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TSUNAMI NEWSLETTER - JULY 1996

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The TSUNAMI NEWSLETTER is published semi-annually in January and July by the International Tsunami Information Center (ITIC) to bring news and information to scientists, engineers, educators, community protection agencies, and governments throughout the world.

We welcome contributions from our readers.

Organized under the auspices of UNESCO's Intergovernmental Oceanographic Commission (IOC), the ITIC is maintained jointly by the National Oceanographic and Atmospheric Administration (NOAA) and the IOC. The Center's mission is to mitigate the effects of tsunamis throughout the Pacific.

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Present membership of the IOC International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) comprises the following 26 Member States:

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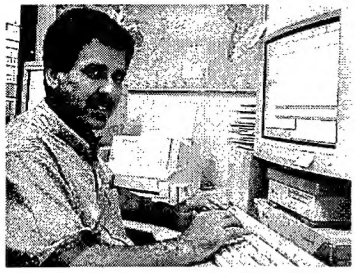
WESTERN SAMOA

TABLE OF CONTENTS



From the Director: My apologies to all Tsunami Newsletter subscribers for the long delay in getting out this issue. With the departure of Salvador Farreras, ITIC Associate Director, who had been very helpful with the previous two newsletters; the occurrence of six tsunamis, three of them destructive, during this reporting period; a recent increase in information requests, particularly from the media; and my own slowness to realize that there are more tsunami-related needs than ITIC resources to apply (in short, overcommitment), timeliness has suffered. In response, I have been taking technical and procedural steps to help streamline the creation of future newsletters. The January 1997 issue should follow this one in short order.

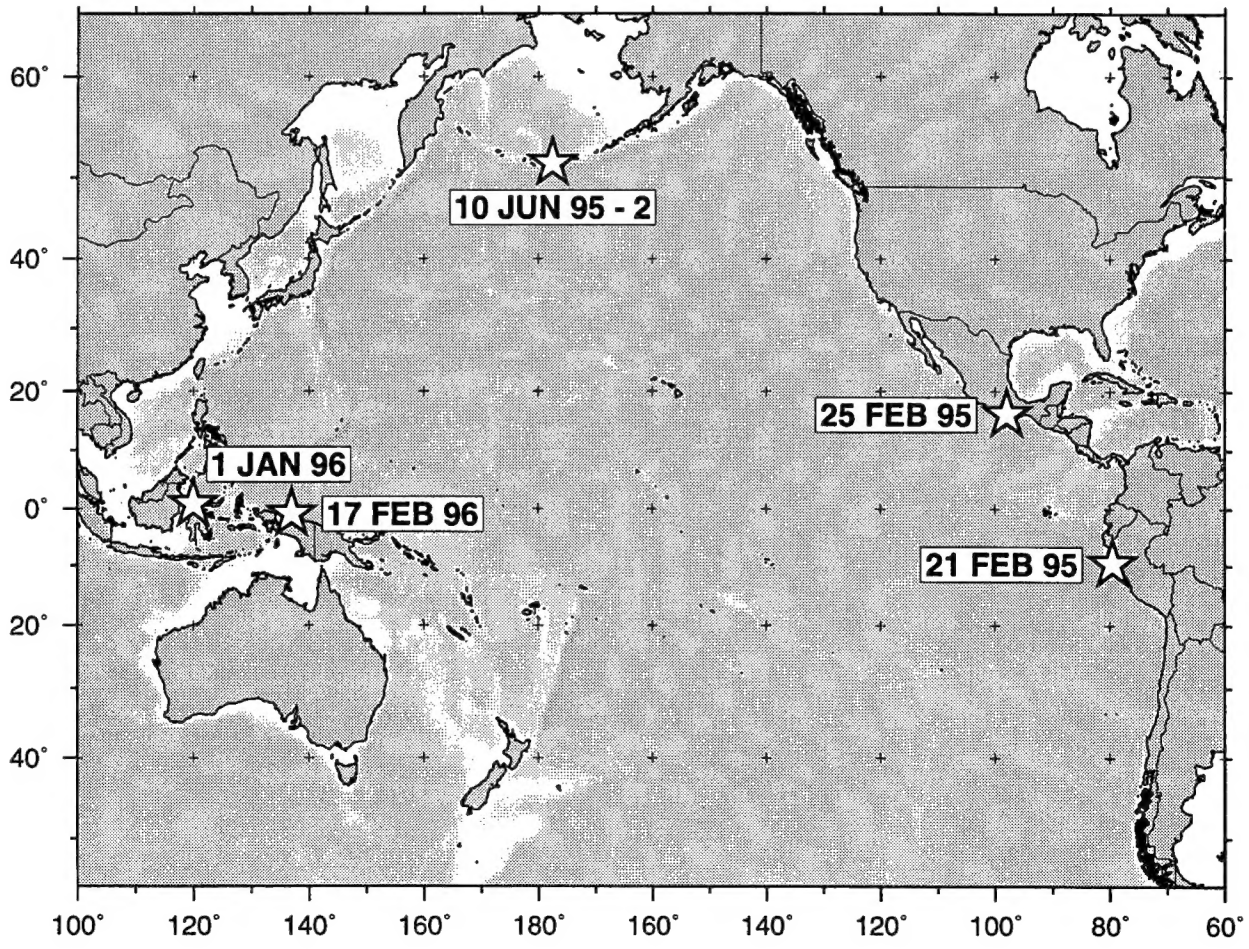
Normally, this issue would include only activities or information received in the January-June, 1996 time frame. But because of the long delay, I have tried to include all time-critical information such as meeting announcements that might otherwise appear in a later issue.

As always, ITIC greatly appreciates the various contributions to the Newsletter as well as other related information that have been kindly sent to this office.

Thanks again for your patience.

TSUNAMI REPORTS: JANUARY - JUNE 1996

Six tsunamis occurred during the first half of 1996. Three of those, two in Indonesia and one in Peru, were very destructive and caused injuries and loss of life. They increased to eleven the number of locally destructive tsunamis that have occurred since the Nicaragua tsunami in September 1992. The other three tsunamis, two from the Aleutian Islands and one from Mexico, had non-damaging, instrumentally recorded waves. The following are brief reports about these tsunamis, representing information received at ITIC from a variety of sources.



Epicenters of tsunamigenic earthquakes in the Pacific area that occurred in the first half of 1996. Local tsunamis generated in Sulawesi, Indonesia (January 1), Irian Jaya, Indonesia (February 17), and Peru (February 21) were destructive and caused up to 182 fatalities.

January 1, 1996, Ms=7.7, M_w=7.8, Sulawesi, Indonesia

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	January 1, 1996 08:05:11.9Z
Coordinates and Depth:	0.724N, 119.981E 33 km
Magnitudes:	mb=6.2, Ms=7.7, Mw=7.8 (GS), Mw=7.8 (HRV), Mo=2.6x10^{20} N-m (PPT)
Region:	Minahassa Peninsula, Sulawesi, Indonesia

Selected Runups (above mean sea level):

(from the international post-tsunami survey)

Pagalaseang Island	2.28 m
Munte	3.17 m
Limbosu	2.81 m
Tonggolobibi	1.82 - 3.43 m
Taipah	2.40 - 3.25 m
Siboang	1.78 m
Siwalempu	1.62 m
Balukang	2.52 m
Soni	1.79 m
Dongko	2.39 m
Simuntu	2.00 m

Wave Amplitudes:

This tsunami was not observed on the nearest Pacific tide gauges at Legaspi, Philippines; Malakal, Belau; Yap and Kapingamarangi, Federated States of Micronesia; and Guam, USA.

Nearby Historical Tsunami:

• ***December 1, 1927 0.5°S, 119.5°E M=6.3***

This earthquake, located near Palu Bay, produced a 15m tsunami in the bay that killed 14 people and injured another 30. The ocean is reported to have become 12m deeper at Talise following the quake, an indication that this unusually large tsunami may have been caused indirectly by submarine slumping.

• ***May 19, 1938 0.5°S, 119.2°E M=7.6***

This earthquake in northern Sulawesi collapsed nearly a thousand homes in one village, and generated a tsunami in Tomini Bay. The tsunami waves reached a height of 2-3m, killing one person at Ampibabo and eighteen at Parigi.

• ***August 14, 1968 0.2°N, 119.8°E M=7.8***

This earthquake occurred off the northern coast of Sulawesi causing subsidence along the coast near Manimbaha Bay of 2-3m, and generating tsunami waves estimated to be 9-10m in height at Donggala. The tsunami killed one hundred sixty, another forty were lost and presumed dead, and 58 were injured. Eight hundred coastal homes were destroyed, and large areas of coastal coconut plantations were flooded.

Descriptive Account

The following account of this event was submitted by Mr. Sunarjo, Head of the Geophysical Division of the Indonesian Meteorological and Geophysical Agency and ITSU National Contact for Indonesia.

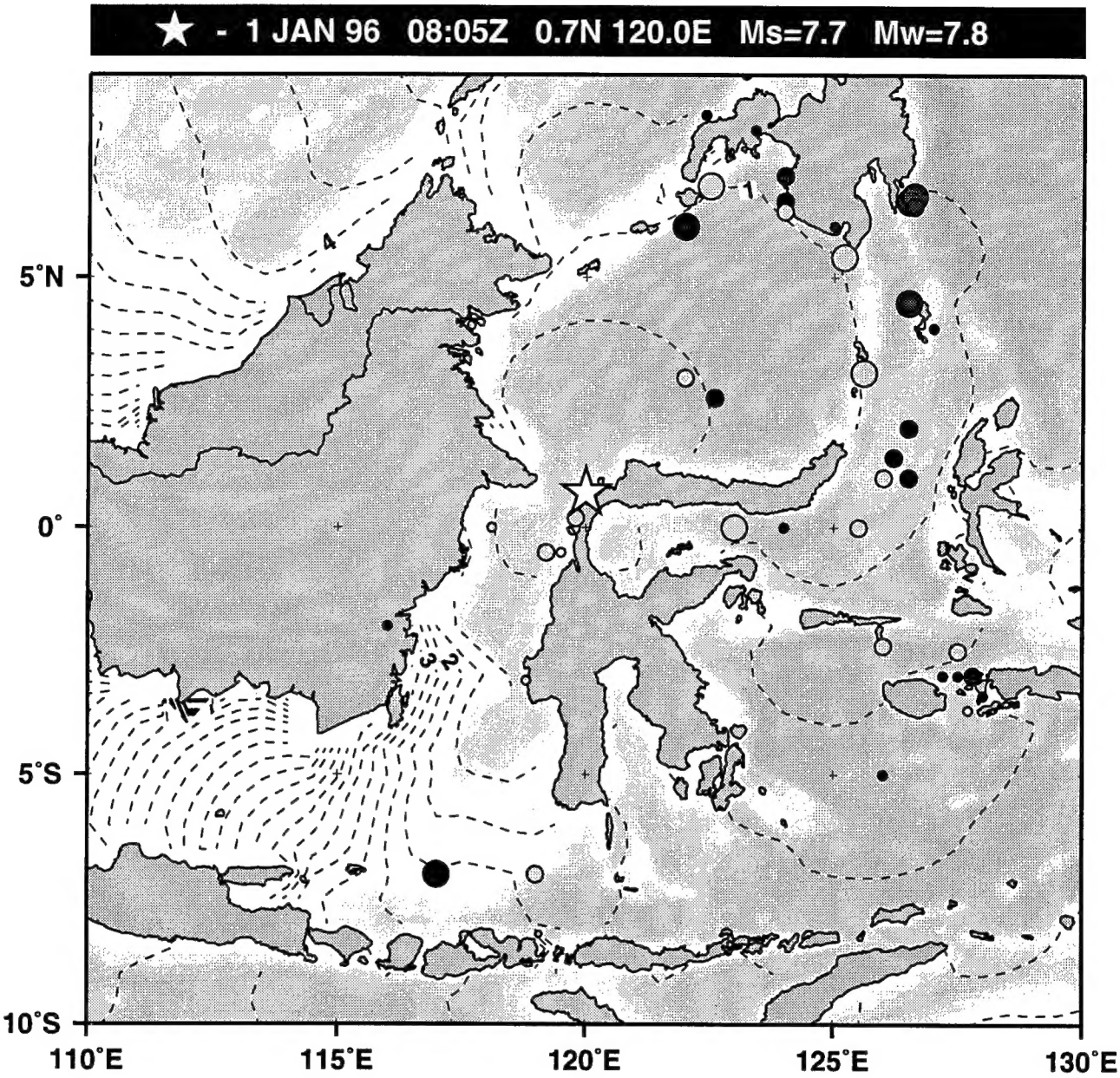
A submarine earthquake, mb=7.0, jolted the Makassar straights and its surrounding area on the first of January 1996 at 08:05 GMT or 16:05 local time, when most of the people were enjoying their New Year's holiday. The earthquake source is located at 0.60°N, 119.92°E, about 160 km north of Palu (the capital city of the North Sulawesi province). The 39-km focal depth earthquake generated a tsunami along the approximately 120-km-long coast of western Central Sulawesi province in which two regencies, Donggala and Buol Tolitoli, were affected. The earthquake was followed by a large aftershock that occurred about an hour later, at 17:14 local time. It originated on the Sulawesi mainland at 0.7°N, 120.5°E and 33-km focal depth.

In the Donggala regency, the most heavily damaged area was Tongglolbibi village which belongs to the Dempelas Sojol district. The tsunami attacked the village about 5 minutes after the earthquake. The tsunami was reported to runup 3-5m and extend about 300m inland. A house drifted 10m from its original foundation, and two 500-ton motor boats drifted 250m ashore. In total, 9 people were killed, 163 buildings (mostly wooden houses) were heavily damaged, and 102 buildings were slightly damaged. The severe effects of the tsunami at Tonggolobibi village were likely due to its location on a concave coastline facing directly towards the epicentral area.

In the Buol Tolitoli regency, the most affected area was Soni village which belongs to the Dampal Selatan district. However, damage here is less than that at Tonggolobibi, and no loss of life occurred. The tsunami was reported to have a runup at Soni of 1.5m and extend 200m inland. In total, 20 buildings (mostly wooden houses) were heavily damaged, and 128 buildings were slightly damaged.

International Post-Tsunami Survey

A post-tsunami survey was carried out three weeks following the earthquake by an international team composed of participants from Indonesia and Russia. Results of this survey, including photos and runup measurements made along approximately 100 km of affected coastline are contained in their report entitled, "The 1996 Sulawesi Tsunamis", by E. Pelinovsky, D. Yuliadi, G. Prasetya, and R. Hidayat published by the Institute of Applied Physics, Russian Academy of Sciences. The runups they measured are summarized above in this article. Additional characteristics of the tsunami such as the number of waves observed, their period, whether the initial wave was a withdrawal, and whether a breaking wave was observed are given in the report. The authors also indicate that subsidence of up to a meter was observed at nearby coastlines following the earthquake.

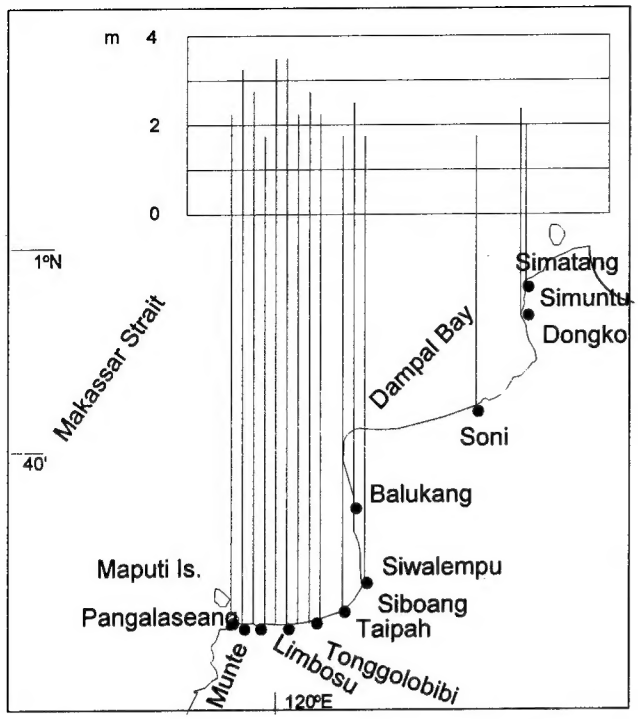


ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◎ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A large tsunamigenic earthquake occurred near the Makassar Straight off the west coast of Sulawesi, Indonesia on January 1, 1996. The tsunami killed 9 persons, injured 63, and destroyed or made uninhabitable over a hundred homes. Runups exceeded 3m in the local area. [Historical data in this figure and others like it in the newsletter are taken from the US National Geophysical Data Center's tsunami database. The ocean depth is qualitatively indicated by shades of gray, with shallow water given lighter tones. Estimated tsunami travel times were computed using software developed by Paul Wessel for PTWC, and the map was drawn with Generic Mapping Tools software.]



Location map and summary of runup measurements made along the northwest coast of Sulawesi by the international survey team (fig. 9 from "The 1996 Sulawesi Tsunamis" by Pelinovsky, et al.).

February 17, 1996, Ms=8.1, M_w=7.9, Irian Jaya, Indonesia

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	February 17, 1996 05:59:29.7Z
Coordinates and Depth:	0.950S, 137.027E 33 km
Magnitudes:	mb=6.5, Ms=8.1, Mw=7.9 (GS), Mo=9.0x10^{20} N-m (PPT)
Region:	Irian Jaya, Indonesia

Tsunami Magnitude: 7.97

Based on the amplitude of the tsunami recorded at 38 sites in Japan, 0.37 ± 0.26m, Katsuyuki Abe of the Earthquake Research Institute of Tokyo University computed a tsunami magnitude of 7.97 just a few days following the event. Since the tsunami magnitude is consistent with moment magnitudes reported for this event, he concluded this is not a "tsunami earthquake".

Selected Maximum Wave Amplitudes (relative to mean sea level at the time):

Ishigaki, Ryuku, Japan	0.16 m
Makurasaki, Kagoshima, Japan	0.50 m
Shionomisaki, Wakayama, Japan	0.96 m
Chichi Island, Japan	1.03 m
Tateyama, Chiba, Japan	0.90 m
Hachinohe, Aomori, Japan	0.19 m
Shemya, Alaska, USA	0.35 m
Adak, Alaska, USA	0.10 m
Port Orford, Oregon, USA	0.04 m
Crescent City, California, USA	0.18 m
Santa Monica, California, USA	0.05 m

Note: High noise levels due to large surf obscured the observation of tsunami waves on gauges in Hawaii.

Selected Runup Values (above mean sea level):

from the international survey team report

N. Biak, Indonesia	1.33 - 5.35 m
S. Biak, Indonesia	0.72 - 2.45 m
E. Biak, Indonesia	1.58 - 3.16 m
W. Biak, Indonesia	1.58 - 7.68 m
S. Supiori, Indonesia	0.60 - 1.56 m
N. Supiori, Indonesia	0.94 - 1.21 m
Pai Is., Indonesia	1.02 - 2.92 m
Owi Is. Indonesia	1.60 - 2.42 m
Auki Is., Indonesia	0.61 - 1.24 m

Nearby Historical Tsunami:

• ***May 23, 1864 1.0°S, 135.0°E M=*.****

A large earthquake in the region of Irian Bay turned over huts on the shore and caused collapses and landslides in the mountains. Immediately following the earthquake, three waves were observed at Mausinam which reached heights of 2½ - 3m above the usual level. All the local settlements on shore were washed away, and 250 people died.

• ***May 26, 1914 2.0°S, 137.0°E M=7.9***

An earthquake in the region of Irian Bay collapsed all brick buildings on Yapen Island. Ansus and Pom were hit by a tsunami following the quake. A tsunami was also observed at Ende, with three successive waves arriving at ebb tide only reaching the height of flood tide. The tsunami also registered on the tide gauge in Honolulu.

• ***September 12, 1979 1.7°S, 135.9°E M=8.1***

A major earthquake occured in the West Irian region causing a tsunami which struck Yapen and Biak Islands. Four hundred houses were reported to have been destroyed and 100 people killed.

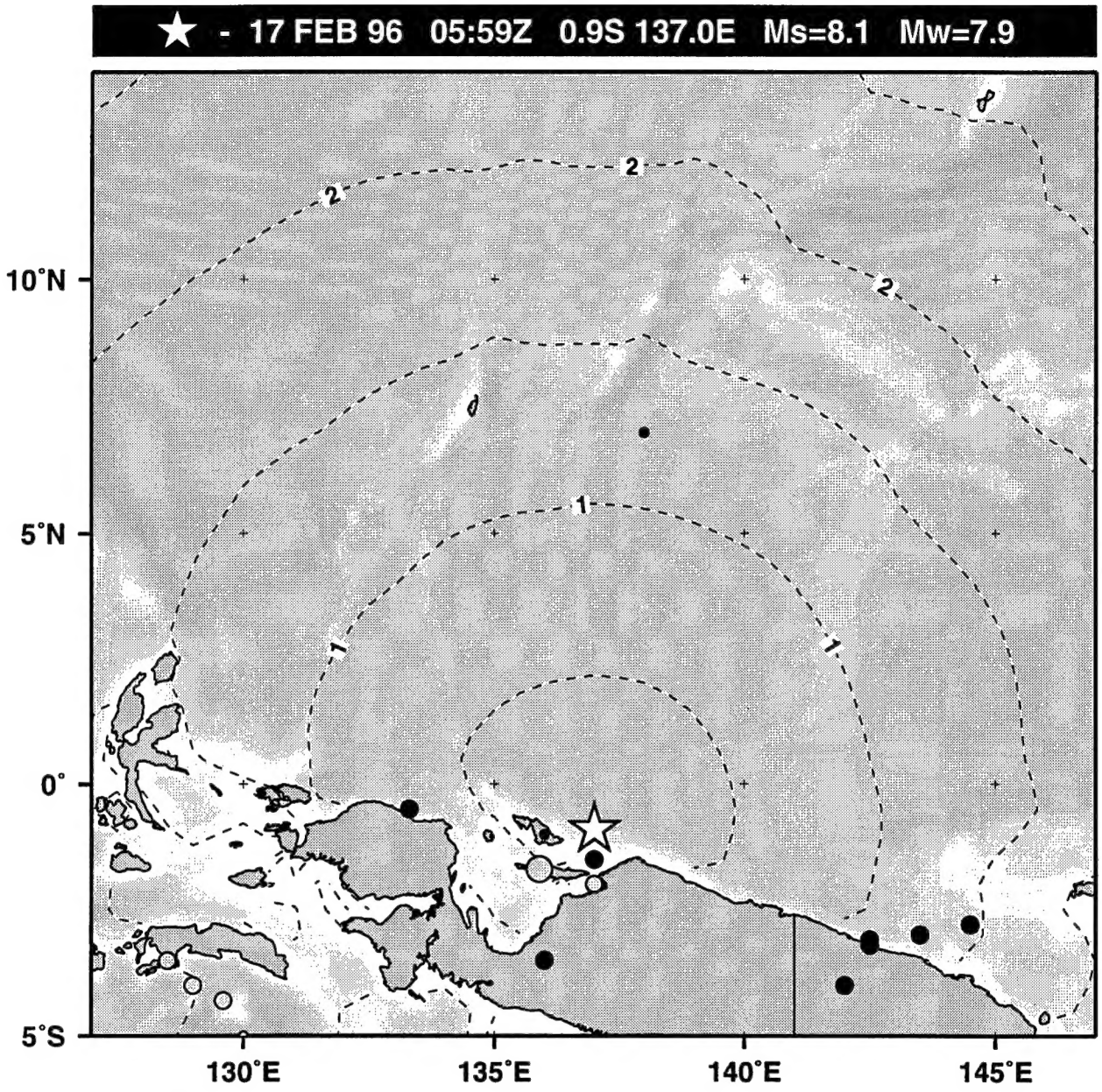
Descriptive Account

(from the international survey team report)

On 17 February 1996, 14:59 (local time and Japan Time), an Mw=8.0 earthquake occurred and was accompanied by a large tsunami, at least 5-7 meter in height, which struck northwestern Irian Jaya. As of 4 March 1996, 107 were reported dead at Biak Island and 3 at Yapen Island, with another 51 missing and around 100 seriously injured. About 10,000 were left homeless.

International Post-Tsunami Survey

Following the earthquake and tsunami, an international team led by Dr. Fumihiko Imamura of Tohoku University and including three Indonesian participants, six additional Japanese participants, and two USA participants was organized to survey the affected area. A summary of their runup measurements is tabulated above and shown in the figure, and a summary of the survey results follows.



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

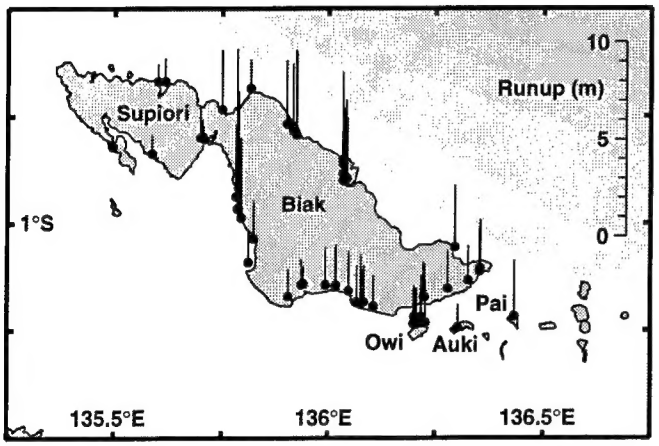
HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
◌ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A great earthquake off the coast of northwest Irian Jaya, Indonesia generated a tsunami that struck Biak and Yapen Islands as well as the coast of Irian Jaya with waves that ran onshore to elevations of up to 5-7 m above mean sea level. The earthquake and tsunami left 10,000 homeless, and 161 persons were either killed or reported missing.

Survey Results

- Severe damage due to the tsunami was observed at Korim, N. Biak, where the tsunami reached as high as 4-5m, and the inundation area is 700m length x 400m width. Damages were caused by a strong tsunami current attacking the flat area at the mouth of the bay.
- A maximum tsunami height of 7.7m was measured at Farusi, Wardo, W. Biak, located on the opposite side of the island from the tsunami source. A phenomenon such as a trapped wave on a coral reef can cause this effect.
- A subsidence ranging from 0.5 to 1.0m in eastern Biak was inferred from interviews with local people. They reported that the level of high tide now is higher than in the past, indicating relatively subsided ground. Similar observations elsewhere were not reported. This may help to estimate the location of the fault rupture.
- Damages due to shaking on a soft sand occurred at Bosnik, E. Biak where many sand boils were found. Almost all houses were collapsed by the quake.



Runup measurements (dot = measurement location, vertical line = runup height) made by the international survey team following the February 17, 1996 tsunami in Irian Jaya, Indonesia. A small discrepancy between measurement locations reported by the team and the coastal database used to produce the underlying map causes certain data points to appear slightly inland or offshore.

February 21, 1996, Ms=6.6, M_w=7.3, Off Coast of Northern Peru

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	February 21, 1996 12:51:04.3Z
Coordinates and Depth:	9.620S, 79.568W 33 km
Magnitudes:	mb=5.8, Ms=6.6, Mw=7.3 (GS), Mw=7.5 (HRV), Mo=3.0x10^{20} N-m (PPT)
Region:	Off Coast of Northern Peru

Tsunami Magnitude: 7.8

Based on the amplitude of the tsunami recorded at Hilo, Hawaii and at Chimbote, Peru (see values below) Katsuyuki Abe of the Earthquake Research Institute of Tokyo University computed a tsunami magnitude of 7.8. Since this is significantly larger than reported moment magnitudes, he concluded that this event is a "tsunami earthquake".

Selected Wave Heights (peak-to-trough):

Chimbote, Peru	148 cm
Salaverry, Peru	>140 cm
Arica, Chile	43 cm
Caldera, Chile	22 cm
Valparaiso, Chile	7 cm
Easter Island, Chile	60 cm
Santa Cruz, Galapagos Is., Ecuador	40 cm
Socorro, Mexico	25 cm
Hilo, Hawaii	30 cm
Kahului, Maui, Hawaii	29 cm

Selected Runup Values (above mean sea level at the time of the tsunami):

from the international survey team preliminary report

Tuquillo	1.97 m
Playa Chimas	3.13 m
Ensenada La Posa	3.61-4.4 m
Playa Alconsillo	1.69 m
Port of Chimbote	3.14-5.04 m
Coishco	2.2-4.7 m
Puerto Santa	1.68-3.28 m
Rio Santa	2.3-3.2 m
Campo Santa	1.38 m
Bocana de Chao	1.41-2.82 m
El Carmelo I.	1.15-2.55 m
La Posa Huanchaco	3.86 m

Nearby Historical Tsunami:

- ***July 9, 1586 12.2°S, 77.7°W M=8.5***

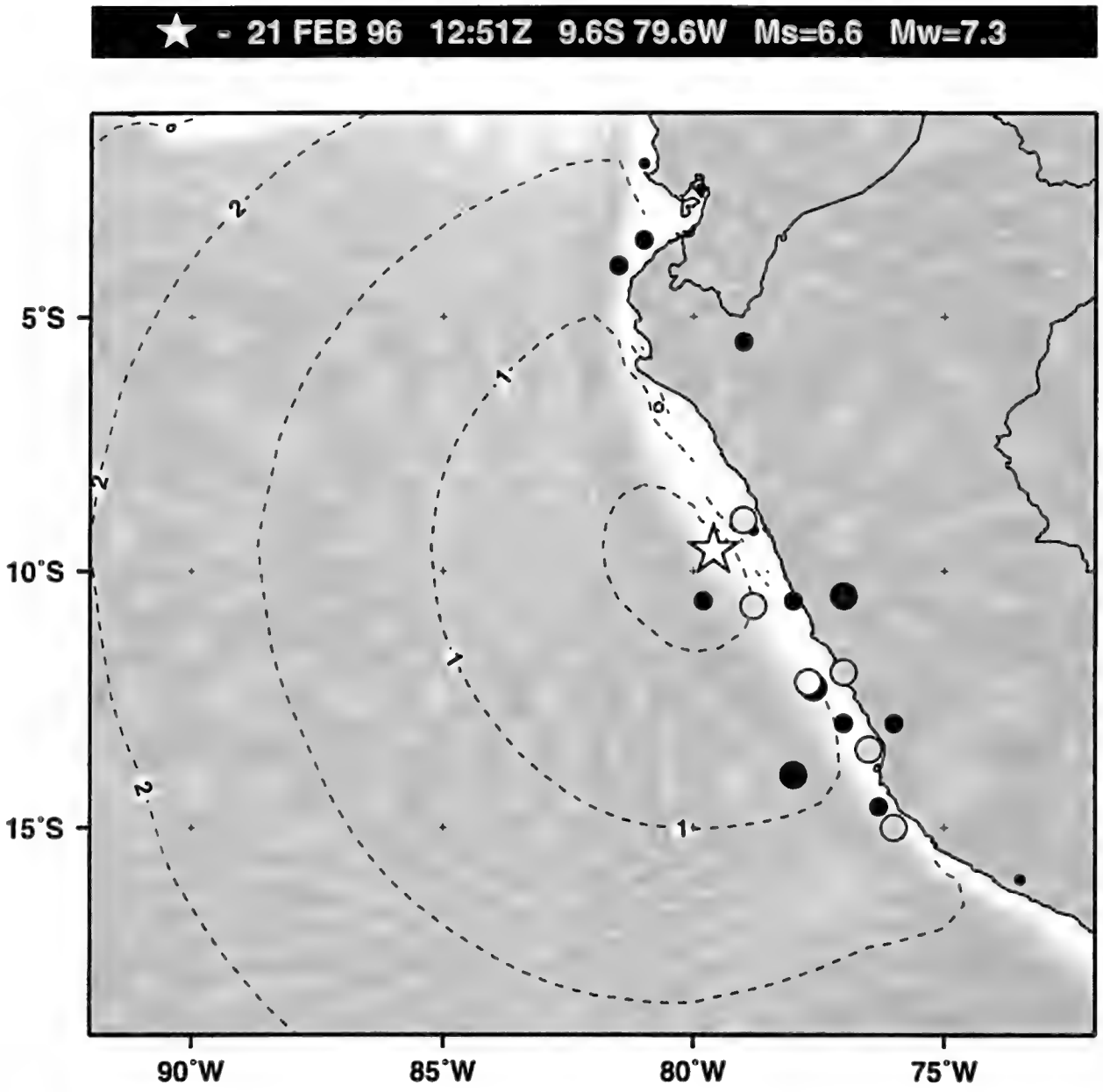
A severe earthquake affected an area of coast 1000 km in length and at least 120 km inland, killing between 14 and 22 persons under collapsed houses. The temblor also generated a tsunami. At Callao, the sea reportedly fell 14m after the earthquake, then rose 24m, inundating the land 250m inland and carrying away trees and bushes. This tsunami is also reported to have propagated across the Pacific to Japan where 1-2m waves hit the northeast shore of Honshu Island.

- ***November 20, 1960 6.8°S, 80.7°W M=6.8***

An earthquake in northwest Peru was felt by local residents and followed by a tsunami in the Lambayeque region. The tsunami, about 9m high, caused damage at Puerto Eten and Pimentel port, and at Santa Rosa and San Jose Bays, with 3 fatalities. The waves also struck the Guañape Islands, just off the coast, killing up to 63 and leaving 800 homeless, with damages estimated at more than US$500,000. The tsunami was recorded as far away as Hilo, Hawaii with an amplitude of 10cm and a period of 14 minutes. The waves are also reported to have been registered by some tide gauges in Japan with a maximum peak-to-trough of 34cm..

- ***October 17, 1966 10.7°S, 78.8°W M=8.0***

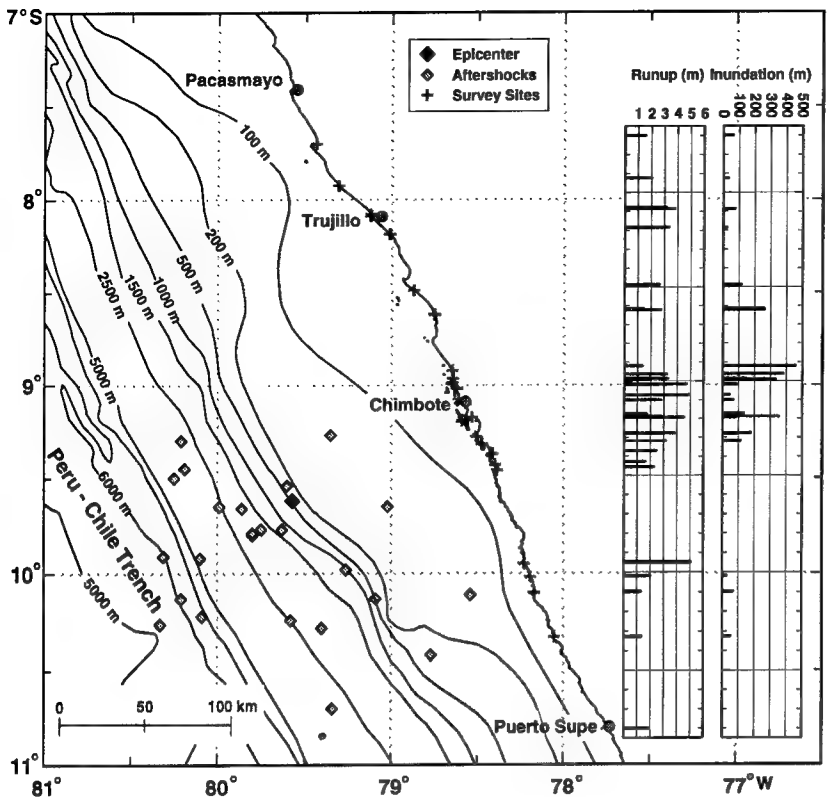
This earthquake caused damage in the coastal zone between about 10°S and 13°S, resulting in 110 dead and 3000 injured, and damages of 35 million US dollars. The earthquake was followed by a tsunami. At Callao, the seventh wave was the largest with a range of 3.5m between



HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
○ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A strong earthquake on the morning of February 21, 1996 off the coast of Peru generated a tsunami that struck the coast of central Peru. Shaking from the earthquake was reported to be mild, and wasn't even noticed along several sections of affected coastline. The tsunami, with runups were as high as 5 m, caused 12 fatalities, 55 injuries, and significant property damage.



Runup and inundation measurements along the coast of central Peru for the tsunami of February 21, 1996 generated by a strong earthquake located southwest of Chimbote.

International Post-Tsunami Field Survey

Following the earthquake and tsunami, a post-tsunami survey was organized by Julio Kuroiwa of the National University of Engineering, Peru, and Harry Yeh of the University of Washington. The survey team included four participants from Peru, six from the USA, and one from Canada. The survey was carried out from March 15 to March 22 and covered approximately 375 km of coast from north of Trujillo to Puerto Supe. Runup and inundation measurements from this survey are summarized in the accompanying table and figure. A comprehensive report, based on the field survey and on modeling results, is now being prepared jointly by scientists at the University of Washington and the National University of Engineering, Peru, for submission to a scientific journal.

the peak and trough. Waves 3m high are reported to have struck Chiquito, Huara, and Trujillo, and also possibly Ancon and Huacho. At Tortuga, the range of oscillations exceeded 6m and washed away many structures. At Casma, ninety percent of the homes were affected, and damages were estimated at 2 million US dollars. The tsunami also registered outside Peru. In Hawaii, the largest signal was a 39cm rise at Kahului, Maui. In Alaska, the waves measured 12cm at three sites. In Japan, the waves registered on at least thirteen tide gauges with a maximum range of oscillations of 38cm at Hachinohe.

Descriptive Account

The earthquake and tsunami occurred at about 8 in the morning local time. Shaking from the earthquake was reported to have been mild, and wasn't even noticed along some parts of the affected coast. Two or three non-breaking tsunami waves were generally observed with the second wave being the largest. At Chimbote, a fishing port 400 km northwest of Lima, seawater rushed over 200m inland flooding two fish processing plants and 50 homes, and damaging many small boats. The Institute for National Civil Defense in Peru reported 12 fatalities from the tsunami, 6 at Coishco and 6 at Rio Santa, and 55 injuries. The fatalities were mostly line fishermen caught on the rocks by the waves. Fifteen houses were also reported destroyed, with another 25 damaged, and 2 boats were destroyed with 23 damaged. Two-hundred-seventy-five persons were compensated for losses including 85 for loss of crops.

February 25, 1996, Ms=6.9, M_w=7.1, Oaxaca, Mexico

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	February 25, 1996 03:08:18.8Z
Coordinates and Depth:	16.204N, 97.963W 33 km
Magnitudes:	mb=5.9, Ms=6.9, Mw=7.1 (GS), Mw=7.0 (HRV), Mo=2.6x10^{20} N-m (PPT)
Region:	Oaxaca, Mexico

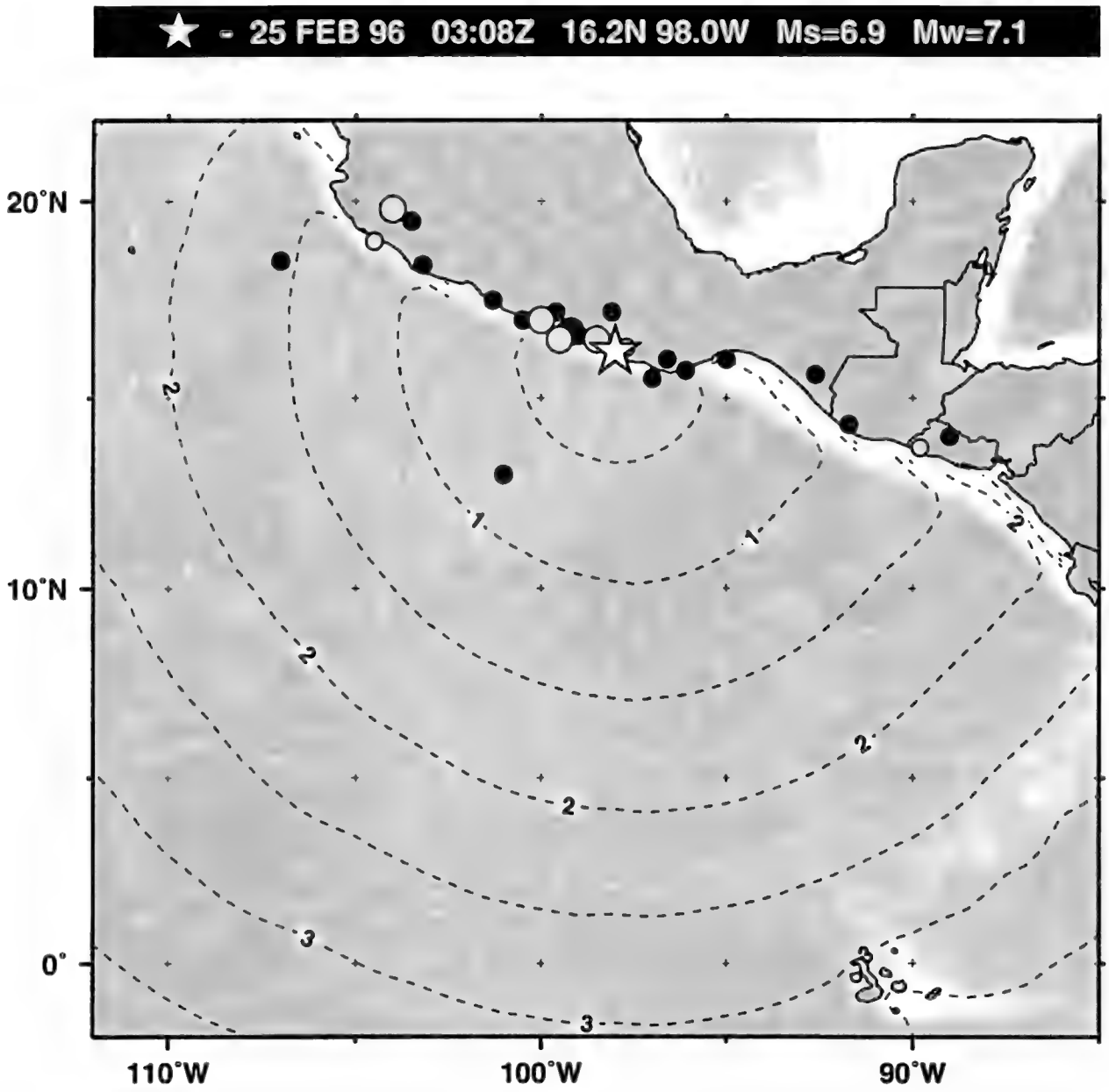
Selected Wave Heights (peak-to-trough):

Baltra Is., Galapagos Is., Ecuador..... 12 cm

Nearby Historical Tsunami:

• ***June 17, 1928 16.3°N, 97.7°W M=7.8***

This earthquake was strongly felt in the Mexican states of Oaxaca, Guerrero, Puebla, Tlaxcala, México, Michoacán, Veracruz, Hidalgo, and part of Tobasco. A tsunami was generated that swept 55m inland at Puerto Angel and destroyed a warehouse. The water also swept 45m inland at Chacalma. The tsunami was also observed outside of Mexico, registering on gauges in California, Hawaii, and Samoa, and having a maximum amplitude of 0.2m at Hilo, Hawaii.



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
○ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	○ 6.9 OR SMALLER

A strong earthquake on February 25, 1996 off the Pacific coast of southern Mexico was felt in the states of Guerrero and Oaxaca. Although no reports of a tsunami being observed along the Mexican coast have been received, waves with a maximum peak-to-trough amplitude of 12 cm were recorded at Baltra Island in the Galapagos Islands.

• ***June 3, 1932 19.8°N, 104.0°W M=8.1***

A great earthquake occurred near the coast of Colima and Jalisco, causing the death of 400 persons in the epicentral area. The earthquake generated a tsunami that was observed in Manzanillo, Cuyutlán, Barra de Navidad, and San Blas. At Cuyutlán, the sea rose and invaded the resort carrying away several houses and flooding the hotel. In Baha San Pedrito, the sea level rose over three meters. The tsunami also destroyed a stretch of railroad tracks between Cuyutlán and Manzanillo. The waves were also recorded across the Pacific in Hawaii, California, and Samoa, with a maximum reading of 0.4m at Hilo, Hawaii.

• ***June 22, 1932 19.0°N, 104.5°W M=7.0***

This earthquake, an aftershock of the June 3 event, caused the collapse of 400 houses in Colima and generated a much larger tsunami locally than the one produced by the main shock. At Cuyutlán, 10m waves destroyed the resort, caused the deaths of 75 persons and injured another 100. Damages were estimated to be up to approximately US$2 million. Not a single house was said to be left standing along a stretch of coast 20km long by 1km wide. The tsunami also registered in Hilo, Hawaii, but with an amplitude of less than a tenth of a meter.

Descriptive Account

A strong earthquake occurred off the southwestern coast of Mexico and was felt in Guerrero and Oaxaca states. The temblor was also felt in Mexico City just to the north. No reports of a tsunami were received from nearby coastal areas, but tsunami waves with a maximum peak-to-trough amplitude of 12cm were clearly recorded about three hours after the quake by the gauge at Baltra Island in the Galapagos Islands, Ecuador. The waves appear to continue for several more hours with a dominant period of about 10-12 minutes. A suggestion of tsunami waves is also indicated on the record from Santa Cruz Island in the Galapagos, but no waves were observed on records from other nearby gauges at Manzanillo or Socorro Island, Mexico or at La Libertad or Cabo San Lucas, Ecuador.

June 10, 1996, Ms=7.6, M_w=7.9, Andreanof Islands, USA

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	June 10, 1996 04:03:35.4Z
Coordinates and Depth:	51.564N, 177.632W 33 km
Magnitudes:	mb=6.6, Ms=7.6, Mw=7.9 (GS), Mw=7.9 (HRV), Ms=7.4 (BRK), Mo=8.6x10^{20} N-m (PPT)
Region:	Andreanof Islands, Aleutian Islands, Alaska, USA

Selected Maximum Wave Heights (peak-to-trough):

Adak, Alaska	102 cm
Shemya, Alaska	15 cm
Unalaska, Alaska	12 cm
Sand Point, Alaska	10 cm
Kodiak, Alaska	13 cm
Midway Island	52 cm
Kawaihae, Hawaii	15 cm
Kahului, Hawaii	55 cm
Nawiliwili, Hawaii	33 cm
Hilo, Hawaii	38 cm
Honolulu, Hawaii	10 cm
Port Allen, Hawaii	20 cm
Johnston Island	3 cm
Port Angeles, Washington	10 cm
Crescent City, California	30 cm
Pago Pago, American Samoa	14 cm
Caldera, Chile	28 cm

Nearby Historical Tsunami:

• ***March 9, 1957 51.5°N, 175.7°W M=8.3***

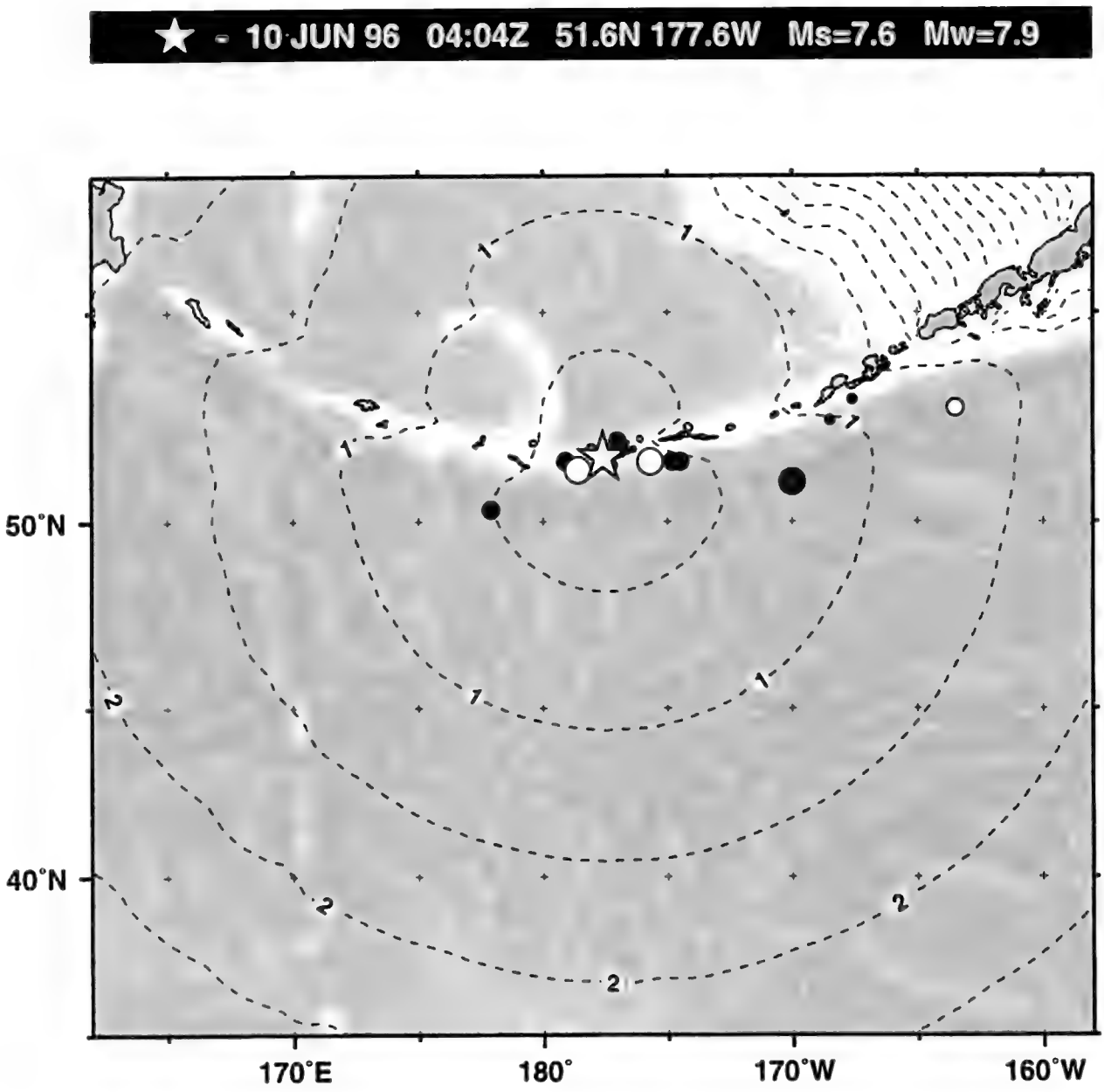
This earthquake produced the largest tsunami in the historical record to have come from the central Aleutian Islands. Based on the aftershock pattern, the earthquake rupture appears to have extended more than 450km from just east of Amchitka Island to just south of Unimak Island. On islands located nearest the source region, wave amplitudes or runups ranged from 4m at Adak to 12m at Unimak to 23m an Umnak. In Hawaii, runups measured above 3m at many locations, and were as high as 16m on the island of Kauai. In the Marquesas Islands a range of oscillations of 6m was observed. Wave amplitudes up to 3m were reported in Japan, and up to 2.1m in Chile. The signal was recorded by over 150 tide gauges. Although the earthquake and tsunami caused considerable damage, no injuries or deaths were reported for this event.

• ***February 4, 1965 51.3°N, 178.6°W M=8.2***

This great earthquake ruptured a 400-km length of plate boundary in the western Aleutian Islands from east of Amchitka to west of Attu. Although the resulting tsunami had a runup of more than 10m at Shemya, flooding a warehouse and washing out part of a road, elsewhere it was much smaller and did little damage. In Japan and Hawaii maximum wave amplitudes were only 1m. Due to the source geometry, most of the tsunami energy probably passed somewhere between Hawaii and Japan.

• ***May 7, 1986 51.5°N, 174.8°W M=7.7***

This earthquake caused minor damage on Adak and Atka, and generated a small tsunami that was widely recorded around the Pacific Basin. In Alaska, it had a maximum amplitude of 88cm at Adak, 12cm at Dutch Harbor, Unalaska, and 5cm at Sand point, Popov Island. A tsunami warning was issued in Hawaii, and coastal areas were evacuated until it was clear the danger had passed. The maximum wave amplitude in Hawaii was 0.6m at Kapaa, Kauai.



ESTIMATED TSUNAMI TRAVEL TIME (LABELED IN HOURS)

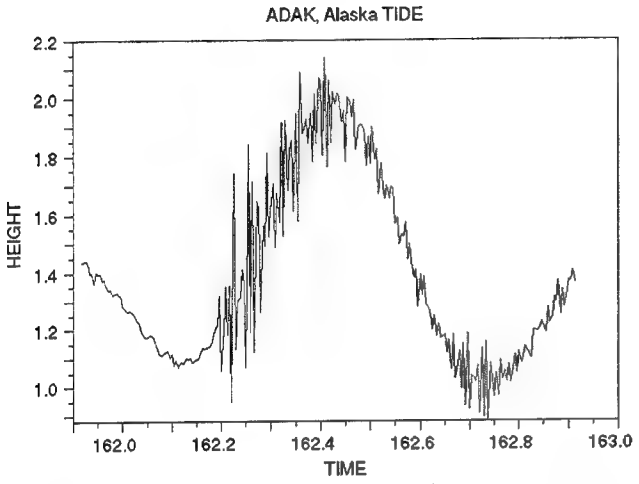
HISTORICAL TSUNAMIGENIC EARTHQUAKES WITHIN 1000 KM.

TSUNAMI EFFECT	EARTHQUAKE MAGNITUDE (Ms)
○ DISTANT DAMAGE	○ 8.0 OR GREATER
○ LOCAL DAMAGE	○ 7.0 TO 7.9
● NO DAMAGE	∘ 6.9 OR SMALLER

A major earthquake occured on June 10, 1996 near Adak in the Andreanof Islands. The epicenter of this event was located very near a March 9, 1957 earthquake that generated a tsunami with runups as high as 23m in Alaska and 16 m in Hawaii. A tsunami was also generated by this event, and although widely instrumentally recorded, was fortunately much smaller and non-destructive. This earthquake was followed by an aftershock eleven hours later that also generated a small tsunami.

Descriptive Account

This major earthquake produced a tsunami that was observed on gauges in Alaska, Hawaii, the US West Coast and as far away as Chile. Because of its proximity to the March 9, 1957 Aleutian Islands earthquake that produced a destructive tsunami in Alaska and Hawaii, this earthquake generated particular concern on the part of the warning centers and public safety officials. Fortunately, the waves from this event did not cause damage or injuries.



Record of the two June 10, 1996 tsunamis recorded on the tide gauge at Adak, Alaska. The time scale on the bottom of the record is in UTC Julian days. This graph was downloaded as a file in a standard graphics format from the WC/ATWC web site (http://www.alaska.net/~atwc/) which contains both graphs and data files of this event from many tide gauges.

June 10, 1996, Ms=7.1, M_w=7.1, Andreanof Islands, USA

Earthquake Parameters:

(from NEIC Preliminary Determination of Epicenters)

Origin Time:	June 10, 1996 15:24:56.0Z
Coordinates and Depth:	51.478N, 176.847W 26 km
Magnitudes:	mb=5.9, Ms=7.1, Mw=7.1 (GS), Mw=7.2 (HRV),Ms=6.9(BRK), Mo=1.1x10^{20} N-m (PPT)
Region:	Andreanof Islands, Aleutian Islands, Alaska, USA

Selected Wave Heights (peak-to-trough):

Adak, Alaska.....36 cm

Descriptive Account

This earthquake, an aftershock of the event eleven hours earlier, produced a tsunami that was only instrumentally observed. The signal from this second tsunami is probably present on more than just the Adak record, but it was not clearly distinguishable on any of the other unprocessed tide records examined at ITIC.

NATIONAL AND REGIONAL ACTIVITIES

The following section contains reports about recent tsunami mitigation activities that have taken place on national and regional levels.

Australia Produces Tsunami Travel Time Charts for the Indian Ocean

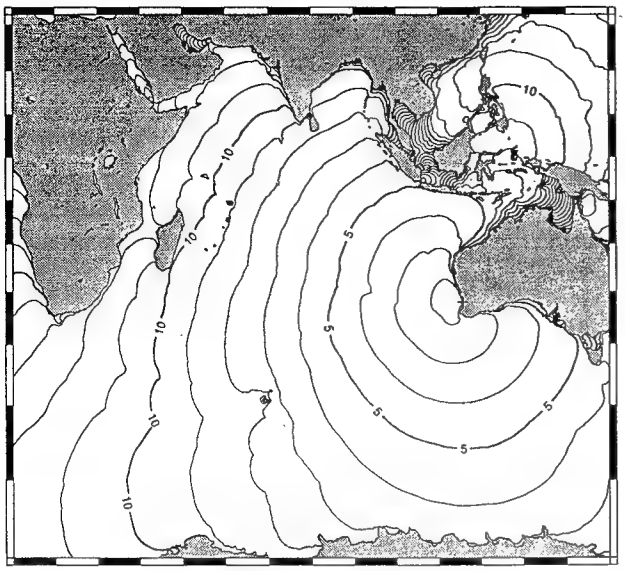
Australia's National Tidal Facility (NTF) has produced inverse isochron tsunami travel time charts for 121 key coastal locations in the Indian Ocean. This work was done voluntarily by the NTF as part of Australia's contribution to the IDNDR, and it is an important step towards establishing a regional warning system in the southeast Indian Ocean for Australia and its neighboring countries. Computations were made using the commercial software package **ttt** (tsunami travel times) available from Geoware, Inc. The work is summarized in a report entitled, "Predicted Tsunami Travel Time Charts for the Indian Ocean" by Peter W. Otto and T.S. Murty.

On the following two pages are examples of the tsunami travel time maps for a dozen locations on the Indian Ocean. The contour interval is hours, and every fifth contour is labeled. Locations shown are: Fremantle and Onslow, Australia; Pacitan and Pariaman, Indonesia; Madras and Bombay, India; Colombo, Sri Lanka; Karachi, Pakistan; Mirbat, Oman; Mogadishu, Somalia; Toamasina, Madagascar; and Durban, South Africa.

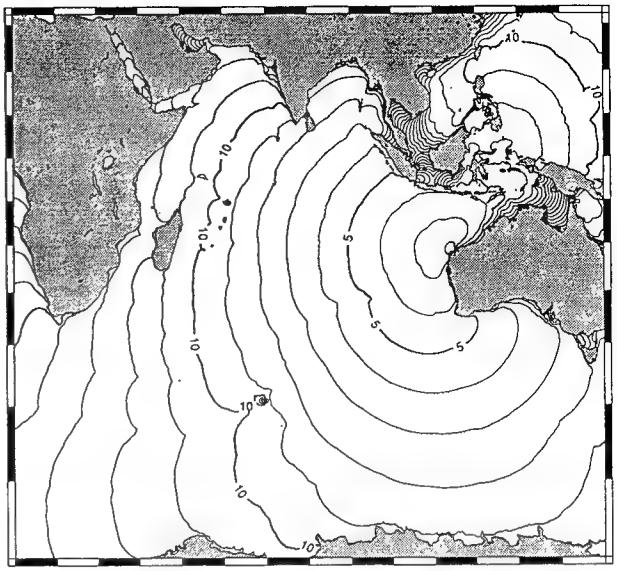
Recent USA Activities

Paleotsunami and other research increasingly indicate that great tsunamigenic earthquakes may occur repeatedly along the Cascadia subduction zone that dips under the northwestern US and western Canada And in 1992, an earthquake near Cape Mendicino, California produced a small tsunami along the northern California coast.. These events have brought about an increased awareness and concern about the tsunami hazard along those coasts - previously thought to have only a minimal risk. In response, a number of new tsunami mitigation activities have taken place recently in the US to address these as well as other long-standing tsunami hazard concerns.

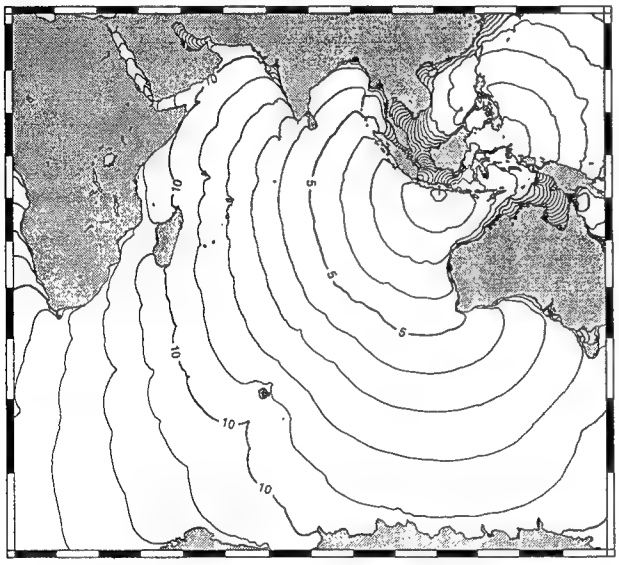
FREMANTLE, AUSTRALIA



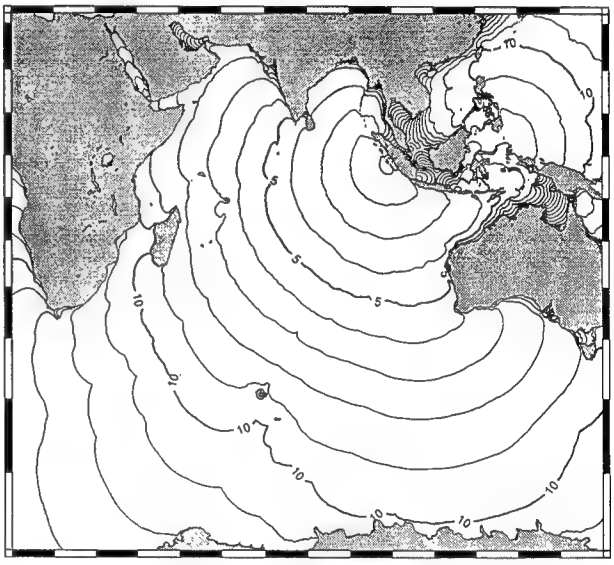
ONSLOW, AUSTRALIA



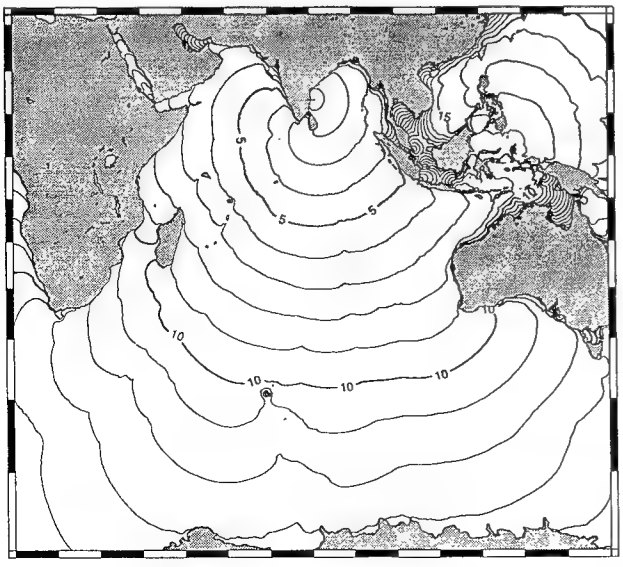
PACITAN, INDONESIA



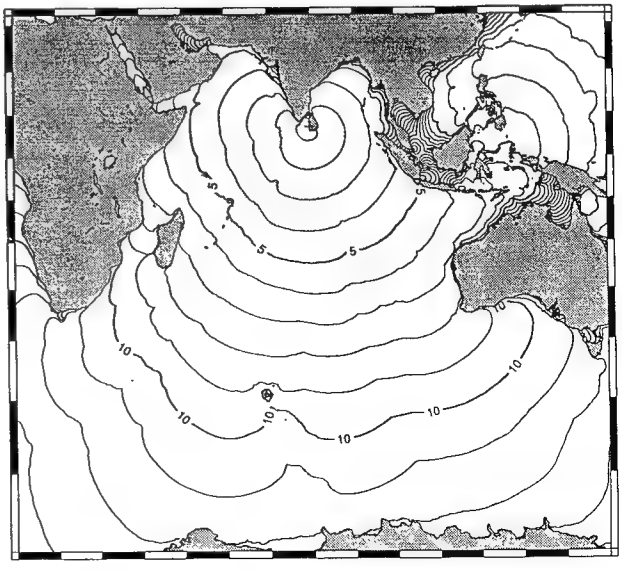
PARIAMAN, INDONESIA



MADRAS, INDIA



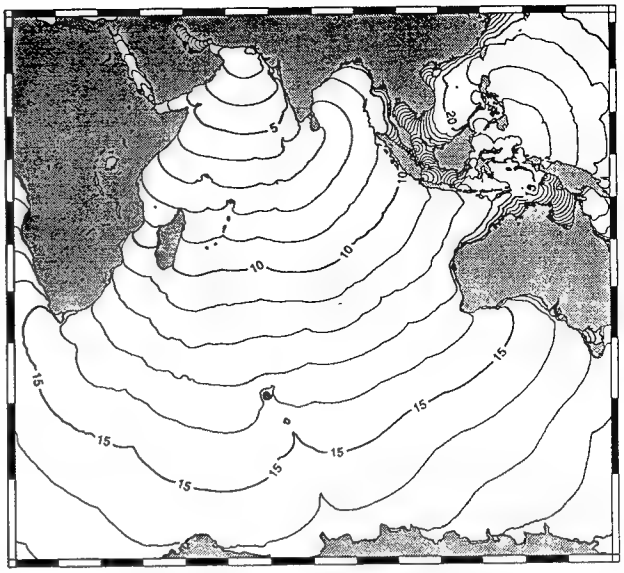
COLOMBO, SRI LANKA



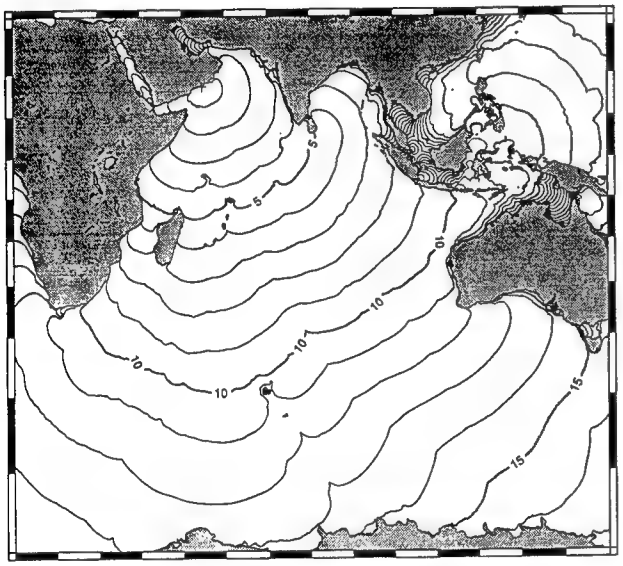
Tsunami travel time charts produced by Australia's National Tidal Facility for sample locations bordering the Indian Ocean.

BOMBAY, INDIA

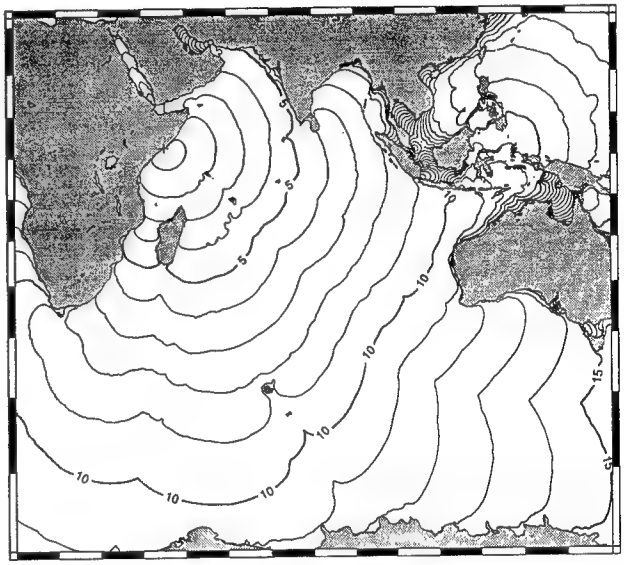
KARACHI, PAKISTAN



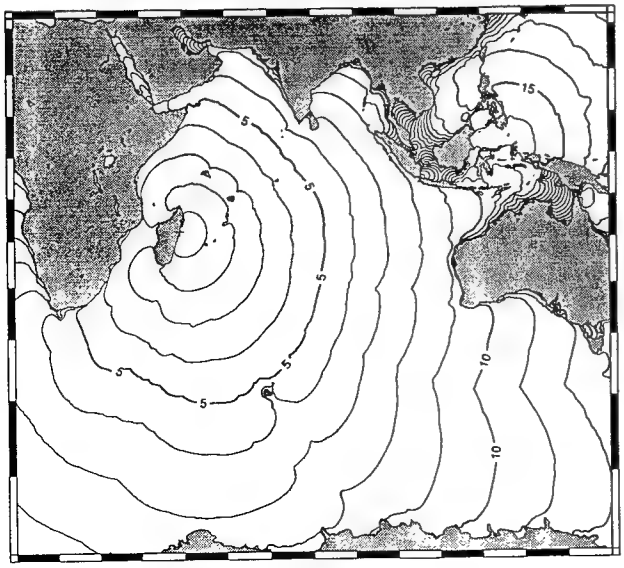
MIRBAT, OMAN



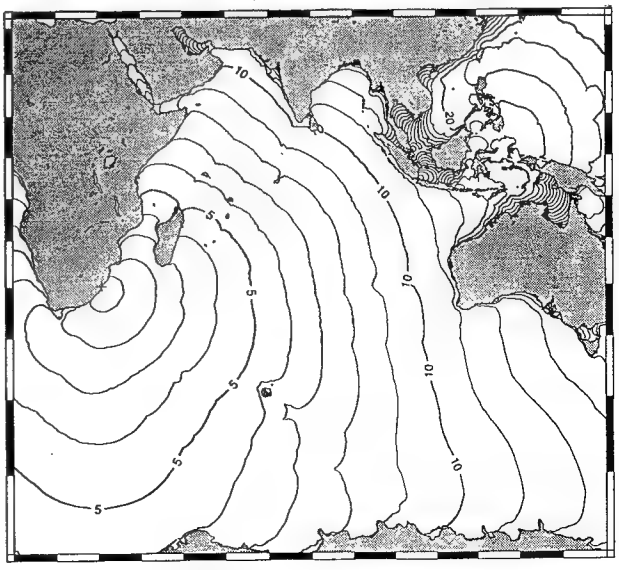
MOGADISHU, SOMALIA



TOAMASINA, MADAGASCAR



DURBAN, SOUTH AFRICA



Tsunami travel time charts produced by Australia's National Tidal Facility for sample locations bordering the Indian Ocean.

Tsunami Hazard Mitigation Implementation Plan

Over the past two-and-a-half years, the US National Oceanographic and Atmospheric Administration, Federal Emergency Management Agency, and US Geological Survey, along with the five US states bordering the Pacific - Alaska, Washington, Oregon, California, and Hawaii - put together a five-year Tsunami Hazard Mitigation Implementation Plan, to be carried out as a federal-state partnership. The plan addresses all aspects of tsunami mitigation - risk assessment, warning guidance, education, and response - with a variety of new activities and strategies.

Of particular interest is the plan to build and deploy six deep ocean bottom pressure sensors for tsunami detection. Signals from the sensors will be transmitted from the ocean floor by acoustic modem to a nearby buoy where they will be further relayed via satellite back to the warning centers. These type of sensors have already proven their capability to measure tsunamis in the deep ocean where tsunami waves are uncontaminated by non-linear shallow water effects that can make signals from tide gauges difficult to interpret. The sensors will also allow for measurement of tsunami waves in critical locations in the north Pacific where there are no islands for siting

Other aspects of the project include the compilation and distribution of inundation/evacuation maps as a basic planning tool for communities at risk; further development of state and local tsunami mitigation programs including the assessment and addressing of needs targeting emergency personnel, government decision makers, private businesses, visitors and tourists, and local residents; and the improvement of seismic networks for local tsunami warning.

Progress reports about this new US effort will appear in future newsletters.

Oregon State Laws Passed for Tsunami Mitigation

In 1995 the legislature in the US state of Oregon passed two important bills to help mitigate its newly recognized tsunami threat from earthquakes along the Cascadia subduction zone. The first of these, Senate Bill 378, addresses emergency procedures in schools. It requires schools in coastal zones to instruct students on tsunami emergencies and to conduct at least three earthquake/tsunami drills each year. The drills and instruction must include an immediate evacuation after an earthquake when appropriate and after a tsunami warning to protect students from inundation. Units of the local government and appropriate state agencies are also required to assist schools with their instruction and drills. The second law, Senate Bill 379, addresses new construction in designated tsunami inundation zones. In particular, it prohibits new construction of essential facilities such as hospital and medical facilities, and fire and police stations, as well as schools and other high occupancy buildings in the designated inundation areas. These are the first state laws to address the tsunami hazard in the US, and they may serve as a model for other coastal states and communities.

Tsunami Hazard Signs

Oregon's Department of Geology and Mineral Resources has developed a set of reflective blue and white tsunami hazard signs for placement in coastal regions. Two designs, available in several sizes, indicate tsunami evacuation routes, or give brief evacuation instructions in case of an earthquake. For further information concerning the cost and availability of this signage contact:

Orville D. Gaylor
Traffic Section, Oregon Dept. of Transportation
132 Transportation Bldg.
Salem, Oregon 97310
USA
Tel: 503-986-3603
Email: orville.d.gaylor@state.or.us

Pacific Tsunami Museum Update

Please Note: To better represent its broad scope, the Hilo Tsunami Museum changed its name to the Pacific Tsunami Museum in November 1996.

April 1, 1996 marked the 50th year since the 1946 tsunami that devastated Hawaii, and in remembrance the Mayor's Office of Hawaii County hosted a public ceremony on the lanai of the County Building in Hilo. The Pacific Tsunami Museum contributed to the program with several items including: an announcement of winners and prizes for the museum's "Do you have a unique tsunami photograph?" contest; a presentation of the first copy of the museum's limited edition poster to Mrs. Fusayo Ito, a Hilo resident who survived the devastating 1960 tsunami after she was washed out to sea by clinging to a floating screen door until she was rescued by a fishing vessel; and a presentation to the museum by Orville Magoon, vintner of the Guenoc Winery, of the first bottle of a special issue 1995 Chardonnay that has the Museum's logo on the label and

will be sold as a fundraiser, with one dollar from each bottle sold going to the museum.

The museum also held a fundraising event at the University of Hawaii at Hilo campus on May 22, 1996 in conjunction with the 36th anniversary of the 1960 tsunami from Chile. The evening featured a sneak preview of Jackie Pualani Johnson's book *Tsunami Years*, entertainment by the Richard Lee Jazz Ensemble, and a singing performance by Diane Aki who performed *La Elima*, a song written by her great aunt about a tsunami in the late 1800's that devastated the Hawaii coastal village of Miloli`i. The museum netted $15,000 from the event.

Pacific Tsunami Museum's 23"x36" color poster showing Hilo, Hawaii residents fleeing from the 1946 tsunami as it came crashing into the Hilo waterfront business district.

The next issue of the newsletter will report on the museum's name change to the "Pacific Tsunami Museum", the securing of a permanent location for the museum, the hiring of a highly regarded firm to create the museum's displays, and a target date for the museum's opening.

To find out more about the museum, visit their web site at: http://planet-hawaii.com/tsunami

Posters...T-Shirts...Tank Tops....Contributions

To order a poster ($25 includes US postage), logo t-shirt ($15 + $3.50 for US shipping and handling) or tank top ($14 + $3.50 for US shipping and handling), or to make a contribution to the Museum, please contact:

Pacific Tsunami Museum
P.O. Box 806
Hilo, Hawaii 96721
USA
tel: 808--935-0926
fax: 808-935-0842
email: tsunami@aloha.net

T-shirts and tank tops come in black or white. The t-shirts are available in M, L, and XL sizes. Women's tank tops come in S, M, and L. Men's tank tops come in M, L, and XL.

TSUNAMI WARNING SYSTEM IN THE PACIFIC (ITSU)

Organized by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the Tsunami Warning System of the Pacific (ITSU) was formed in 1965 in response to a series of destructive Pacific-wide tsunamis, most notably the May 1960 tsunami from the great Chile earthquake that swept rapidly across the entire Pacific Basin causing significant damage and casualties as far away as Japan. ITSU currently consists of 26 Member States (listed on the inside front cover) that cooperate on and coordinate their tsunami mitigation activities. National Contacts from each of the Member States form an International Coordination Group (ICG/ITSU) that meets approximately once every two years to review progress and set goals.

Sixteenth Session of ICG/ITSU

The sixteenth session of the International Coordination Group for the Tsunami Warning System in the Pacific (ICG/ITSU) will take place, at the kind invitation of the government of Peru, in Lima, September 23-26, 1997. Attendees will include the respective National Contacts of ICG/ITSU from its 26 Member States, the Officers of ICG/ITSU, and a number of other invitees.

Cdr. Guillermo Hasembank Rotta, ITSU National Contact for Peru, at the recent ITSU Officers Meeting where he briefed the group on arrangements in Peru for the next meeting of ICG/ITSU.

Topics on the provisional meeting agenda include national reports on tsunami program activities, and reports on the Tsunami Inundation Modeling Exchange program, the real-time exchange of seismic and tsunami data, and the Expert Tsunami Database for the Pacific. Interaction with other bodies and programs such as the Tsunami Commission, IDNDR, IOCARIBE, the tsunami program in Europe, the International Year of the Ocean, and Expo 98 will also be discussed. Some potential new projects will also be presented including a new Pacific Historical Database, and a Tsunami Glossary and Encyclopedia.

ITSU Officers and National Contacts Update

In the January 1996 issue of the Tsunami Newsletter, a complete list of ITSU Officers and National Contacts was published, with an address, phone, fax, and email for each. Please note the following corrections and changes to the list:

Peru National Contact: Early in 1996 ITIC was informed that Peru had designated Cdr. Guillermo Hasembank Rotta as its new ITSU National Contact, replacing Lt. Cmdr. G. O. Bawden.

Cdr. Guillermo Hasembank Rotta
Chief of the Office
Peruvian Tsunami Warning System
Direccion de Hidrografia y Navegacion de la Marina (HIDRONAV)
Street Gamarra #500
Chicuito-Callao
Peru
Tel: <51> (14) 29 72 90
Fax: <51> (14) 65 29 95
Email: hidronav+@amauta.rcp.net.pe

Philippines National Contact: The Philippine Institute of Volcanology and Seismology (PHIVOLCS) began moving into their new building this past December. Consequently, the coordinates for Raymundo Punongbayan, the Director of PHIVOLCS and ITSU National Contact for the Philippines, have changed to:

Dr. Raymundo S. Punongbayan
Director
Philippine Institute of Volcanology and Seismology
C.P. Garcia Avenue, U.P. Diliman
Quezon City
Philippines
Tel: <63> (2) 926 2611
Fax: <63> (2) 929 8366
Email: delfin@phivolcs.dost.gov.ph

Nicaragua National Contact: ITIC was informed in late January, 1997, that Ing. Claudio Gutiérrez Huete had succeeded Ing. Cesar Aviles-Haslam as Director General of the Instituto Nicaraguense de Estudios Territoriales (INETER), and also as ITSU National Contact for Nicaragua, a position he previously held in 1993 and 1994.

Ing. Claudio Gutiérrez Huete
Director General
Insituto Nicaraguense de Estudios Territoriales
P.O.Box 2110
Managua
Nicaragua
Tel: <505> (2) 49 6986
Fax: <505> (2) 49 1890
Email: Ineter@ibw.com.ni

United Kingdom (Hong Kong) National Contact: Mr. Robert Lau retired in December, 1996, and Dr. H.K. Lam succeeds him as Director of the Royal Observatory and ITSU National Contact for Hong Kong.

Dr. H.K.Lam
Director
Royal Observatory
134A Nathan Road
Kowloon
Hong Kong
Tel: <852> (2) 926-8200
Fax: <852> (2) 311-9448
Email: mailbox@hko.gcn.gov.hk

France National Contact and ICG/ITSU Vice-Chairman: Francois Schindele has taken a new position in Paris as head of one of the seismology branches of the Laboratoire de Géophysique. His new coordinates are:

Dr. Francois Schindele
Head LDG/DSO
Laboratoire de Géophysique
BP 12
91680 Bruyeres-le-Chatel
FRANCE
Tel: <33> (1) 69 26 78 09
Fax: <33> (1) 69 26 70 00
Email: schindele@ldg.bruyeres.cea.fr

Russian Federation: A more detailed mailing address and new fax number are available:

Dr. Igor P. Kuz'minykh
Deputy Chief, Central Design Office
Hydrometeorological Instrument Production Engineering
6 Korolev Street
Obninsk, Kaluga Region
249020 Russia
Tel: <7> (08439) 2 74 22
Fax: <7> (095) 255 22 25

U.S.A. National Contact: Mr. Richard Hagemeyer

Email: Richard.Hagemeyer@noaa.gov

ITIC Director: Dr. Charles S. McCreery

Fax: <1> (808) 532 5576
Email: itic@itic.noaa.gov

ITIC Associate Director: Mr. Salvador Farreras' appointment to ITIC as Associate Director was completed at the end of April 1996. The position is currently empty.

IOC Secretariat: Dr. Iouri Oliounine

Fax: <33> (1) 45 68 58 12

As always, please advise ITIC of any errors or changes to the name, address, phone, fax, or email of the ITSU Officers or National Contacts so these changes can be noted in the Newsletter.

TIME and TREMORS Training in Chile

(summary provided by SHOA)

In accordance with what was announced by the Chilean Delegate at the XV session of ICG/ITSU held in Papeete during July 1995, the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA) designed and conducted a course entitled "Numerical Simulation of Tsunami" between March 8 and May 11,1996.

The course was part of the technological capacity building in relation to the Tsunami Inundation Modeling Exchange (TIME) project, based on the advances achieved by Dr. Nobuo Shuto of the University of Tohoku, Japan in the Numerical Analysis Model for the investigation of tsunami in the near field. The course also included a training session on the TREMORS system (Tsunami Risk Evaluation through Seismic Moment from a Real-time System) developed by France and recently installed by SHOA in Chile.

The technological transfer was possible thanks to an agreement signed between the SHOA and the Centro de Investigaciones Cientificas y de Educacion Superior de Baja California, Mexico (CICESE) and under the auspices of the Intergovernmental Oceanographic Commission (IOC) and the cooperation of the Laboratory of Geophysics of French Polynesian (LDG/CPPT). The TIME portion of the course was conducted by Professor Modesto Ortiz Figueroa from CICESE and the TREMORS portion by Dr. Francois Schindele, (former) head of the LDG/CPPT.

Participant experts were Miss Patricia Arreaga from the Instituto Oceanografico de la Armada del Ecuador; Mr. Fernando Ureña from Servicio Mareografico y de Estado de Mar de Costa Rica; Mr. John Caicedo from the Observatorio Sismologico del Suroccidente de Colombia; Miss Carolina Martinez, Mr. Francisco Leiva and Mr. Dante Gutierrez from the Servicio Hidrografico y Oceanografico de la Armada de Chile. All of them finalized the course by developing a simulation of a tsunami striking some coastal region in their own country. Ecuador worked in Golfo de Guayaquil (2-4°S, 79.5°-82°W); Costa Rica worked in Golfo de Nicoya, Punta Arenas y Quepos (8.5°S, 84°-87°W); Colombia worked in area of Tumaco (1°-3°N, 78°-80°W); Chile in Iquique (20°11'-20°13'S, 70°10'-70°08'W); Arica (18.44°-18.48° S, 70.42°-70.28°W) and Antofagasta (24.44°-23.02°S, 70.44°W). Inundation maps were prepared for the corresponding areas of interest.

A more detailed summary of this project has recently been published in Español as number 42 in the series of IOC/UNESCO Training Course Reports.

Participants in the TIME and TREMORS training course that took place in Chile from March 8 through May 11, 1996. From left to right, Mr. Dante Gutierrez (Chile), Mr. Francisco Leiva (Chile), Mr. John Caicedo (Colombia), Miss Patricia Arreaga (Ecuador), Captain Hugo Gorziglia (Director, SHOA and Chairman, ICG/ITSU - Chile), Miss Carolina Martinez (Chile), Mr. Fernando Ureña (Costa Rica), Professor Modesto Ortiz (CICESE - Mexico), and Commander Alejandro Cabezas (Head, Oceanography Department of SHOA - Chile).

Mike Blackford (seated), Geophysicist-in Charge at the Pacific Tsunami Warning Center, briefs NTF Director Dr. Tad Murty (center) and IOC Executive Secretary Dr. Gunnar Kullenberg (right) on operations at the recently renovated center.

IOC Executive Secretary and NTF Director Visit ITIC & PTWC

Following the PACON '96 meeting held in Honolulu, Hawaii in June, 1996 (meeting summary appears later in this newsletter), Dr. Gunnar Kullenberg, IOC Executive Secretary, and Dr. Tad Murty, Director of Australia's National Tidal Facility, made visits to ITIC and PTWC. They were briefed on the current activities of both centers, and all parties exchanged useful information on various issues of common interest, including ideas for funding of post-tsunami surveys, the exchange of water level data between PTWC and NTF, and arrangements for a storm surge workshop to be held in India.

INTERNATIONAL TSUNAMI INFORMATION CENTER (ITIC)

The International Tsunami Information Center (ITIC) was formed along with ITSU in 1965, and it serves to support the ongoing activities and goals of ITSU. Its mandate includes virtually all aspects of tsunami mitigation, and some of its activities include the production of this newsletter and an annual training program for visiting experts from around the Pacific.

Transfer of the Tsunami Bulletin Board to ITIC

The Tsunami Bulletin Board (TBB), an email distribution system for tsunami researchers, was created following the Nicaragua Tsunami of 1992 by the Pacific Marine Environmental Laboratory (PMEL) to disseminate news and information on tsunami events, to serve as a forum for discussions and ideas on tsunami research, and to encourage and facilitate data sharing. After more than four years at PMEL, operation of the TBB has recently been turned over to the International Tsunami Information Center. Some general information about the TBB is summarized below.

To Subscribe: Send an email message to: listserv@itic.noaa.gov with "SUBSCRIBE TSUNAMI" as the body of the message. This request will be forwarded to the ITIC Director who will ask you to provide the following additional information:

a. Your name
b. Your best mailing address
c. Your best voice phone number
d. Your best fax number
e. Your best internet e-mail address
f. A short description of your position and your research interests in tsunamis.

Please note that in order to keep postings to a minimum, and their content focused, the TBB is currently restricted to persons or offices actively involved in tsunami research. ITIC may host an email list for a broader range of interested subscribers at some time in the future.

To Unsubscribe: Send email to listserv@itic.noaa.gov with "UNSUBSCRIBE TSUNAMI" as the body of the message if you want to stop receiving postings.

To Post a Message: Send the message to tsunami@itic.noaa.gov. The message sent back to you, as a normal TBB posting, will serve as confirmation. You may also be notified about recipients that couldn't be reached due to email problems.

To Reply to a Message: Using the *reply* command of your own email software will send that message only to the person who originally posted the message. If you wish to reply to the entire TBB you must specifically email it to tsunami@itic.noaa.gov or *CC* to that address in your reply. If you receive back a copy of your message (with no error indications), you will know it got posted successfully.

Adiós to the ITIC Associate Director

Salvador Farreras finished his one-year term as ITIC Associate Director at the end of April, 1996. During his term, Salvador assisted with the routine operations of ITIC and also worked on a number of special projects including updates to the ICG/ITSU Master Plan, the establishment of regional tsunami warning systems, a post-tsunami survey field guide, reorganization and automation of the ITIC library, and preparation of various educational materials. Salvador also provided a great deal of continuity for ITIC during its transition between Directors, and also during the move to the new ITIC office which occured at the same time. The IOC, ICG/ITSU, and ITIC are grateful to Mexico and to CICESE for supporting his year-long posting to this position.

Nominations for a new ITIC Associate Director are currently being sought through the ITSU National Contacts, and a new arrangement is being considered whereby the position could be carried out from the appointee's home country, rather than having to move to Honolulu.

Richard Hagemeyer(left), ITSU National Contact for the USA, Chip McCreery (center), ITIC Director, and Salvador Farreras (right), ITIC Associate Director, share refreshments and exchange some final thoughts at Salvador's farewell party, a few days before his return to Mexico.

INTERNATIONAL DECADE FOR NATURAL DISASTER REDUCTION (IDNDR)

Planning the Final Years of the IDNDR

The following article by Robert M Hamilton, Chairman of the IDNDR Scientific and Technical Committee, was reproduced from the March 1997 issue of the Natural Hazards Observer.

The International Decade for Natural Disaster Reduction (IDNDR), a United Nations program for the 1990s, is entering its closing phase. The U.N. General Assembly has authorized a "closing event" during 1999 and has designated the IDNDR Secretariat in Geneva as the office in charge of the event and of the preparatory process leading to it.

Planning the closing process and the strategy to be pursued in disaster reduction beyond the year 2000 were the main topics of discussion when the IDNDR Scientific and Technical Committee (STC) met at UNESCO Headquarters in Paris, January 20-24, 1997. The STC advises the United Nations Secretary-General on matters related to the Decade and the development of its overall programs.

The nature of the "closing event" is yet to be determined. It appears that the major donors for U.N. conferences are weary of large, politicized events, and have in mind a more modest conference to wrap up the Decade. The Secretariat is exploring options, one of which would be a meeting in Geneva at the Palais des Nations. Alternatively, a meeting in a hazard-prone, developing country would be welcomed by many Decade participants as an ideal venue to highlight natural hazard issues and to showcase mitigation methods.

The STC recommended that the title of the closing event should be "Second World Conference on Natural Disaster Reduction." This, of course, builds on the World Conference held at Yokohama in May 1994, and implies that there will be future events, because efforts to mitigate and prevent impacts from natural disasters will go on after the Decade as integral activities in the many organizations that participate in the IDNDR.

Suggestions were made that all organizations participating in the Decade provide a report on their IDNDR activities and that the conference sessions be organized by topics, including progress toward meeting the three IDNDR targets: assessment of risks, completion of disaster reduction plans at national and local levels, and provision of access to early warning systems.

UNESCO / INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

International Year of the Ocean / Expo 98

(report taken in part from the UN and Expo 98 web sites)

In July, 1994, the General Assembly of the United Nations, as called for by the General Conference of UNESCO, proclaimed 1998 the International Year of the Ocean to call attention to the decisive role that the oceans play in shaping the life of the planet. One of the most important activities to take place during the Year will be Expo 98, to be held in Lisbon, Portugal from May 22 to September 30, 1998.

The last decade of our century will be marked by the great debate on how the oceans are to be integrated into the sustainable development of the planet. Bearing in mind the increasingly intensive use of the oceans, it is decisive for world ecological balance to avoid the threat of rapid destruction of their formidable potential of life and resources. For this reason, the theme of the 1998 Exposition will be "The Oceans, A Heritage for the Future".

The idea of heritage is seen from two angles - on the one hand, to teach us to value the physical and educational assets offered to us by the oceans, and on the other, a direct association with the idea of conservation and responsibility to future generations. In this way, the discourse of the exposition, which is intended to usher in a more scientific and ethically based way of thinking, will be organized in various categories with the proposed sub-themes:

- Knowledge of the Seas, Ocean Resources
- The Oceans and the Earth's Ecological Balance
- The Oceans and Leisure
- The Oceans, a Source of Artistic Inspiration

As the central thread, the Expo 98 theme provides unity between the Pavilions of the Organizers and official and non-official participants, and will be seen both in public areas, and in cultural activities, which will take place throughout the Exposition. In this way, the theme will be present throughout the Exposition Ground.

Expo 98 has so far received confirmation of attendance from 121 countries and organizations, making it the most international of all world Expositions. The web URL for Expo 98 is: http://www.expo98.pt

RECENT MEETING REPORTS

IOCARIBE Consultation of Experts on Tsunamis

May 23-24, 1996, Environmental Resources Station, St. John Island, Virgin Islands

(information in the following report was exerpted from an article by George Maul of the Florida Institute of Technology (gmaul@marine.fit.edu) for the IOCARIBE News)

Responding to concerns expressed during SC-IOCARIBE-V, the fifth meeting of the IOCARIBE (Barbados, 1995), a small workshop of scientists was convened to discuss threats and mitigation strategies for the next Caribbean Sea and Adjacent Regions (or the "Intra-Americas Sea" as some of us prefer) tsunami.

Now, is it really a "Wider Caribbean Region" threat? Well, yes! Very destructive tsunamis occurred in 1692, 1755, 1761, 1842, 1867, 1918, and 1946 scores of smaller ones are in the records too. Run-ups associated with our tsunamis are not as great as the Pacific and Indian Ocean events, but some typical numbers are 4-7 meters (13-23 feet) in several fully-documented cases, and thus larger than the largest recorded hurricane-generated storm surges. The potential for severe damage is quite well understood from observations and anecdotal evidence. What makes it worse, is to couple the tsunami threat with our population growth. In 1867 say, the year of the great Virgin Islands tsunami, the population of the Caribbean area was about 3 million persons. Now, the population is greater than 30 million persons, most of whom have chosen to live in the coastal zones of our island and continental shores (even me, fool that I am, live in a beach-house). Imagine the 1867 tsunami's 5 meter (17 foot) high wave crashing into Charlotte Amalie harbor today, without warning, with a 10-fold plus higher population density, while three cruise ships and several heavily lightered fuel barges are in the harbor, and two tourist-laden jets are waiting for take-off at the St. Thomas airport!

Sounds like the script for a Hollywood disaster movie, but it's all too real. Against this backdrop, our scientific meeting was held. A small-group effort was convened at this stage to begin to appreciate the magnitude of the problem. Later the group's size and composition will be changed so that different persons are involved. But at the outset, the IOCARIBE Secretariat, in execution of Resolution #3 from SC-IOCARIBE-V, convened this expert consultation.

Participants included oceanographers, seismologists, meteorologists, geologists, tsunami-warning experts, and the IOCARIBE Secretary, Capt. Rafael Steer. It was hosted by Prof. Roy Watlington at the University of the Virgin Islands Environmental Resource Station (VIERS), sponsored and supported by NOAA's Southeast Fisheries Science Center, the University of the Virgin Islands, and the Intergovernmental Oceanographic Commission of UNESCO; I had the honor of being the meeting Chairman.

The first day of the meeting was Thursday May 23rd, with general introductions and welcoming. Next, the following series of invited technical talks were given: Mr. James Lander - History of tsunamis in the Caribbean. Mr. Lloyd Lynch - Report on the current volcanic activity on Montserrat. Dr. Haraldur Sigurdsson - Caribbean volcanoes: status of Kick'em Jenny Volcano. Prof. Aurelio Mercado - Predicting and modeling of tsunami effects. Mr. Michael Blackford - The Pacific tsuanmi warning system. Mr. Douglas Martin - Status report: OAS Caribbean sea level monitoring system. Dr. Hans Meyer - The Colombian near-source tsunami warning network for the Pacific. Following these lectures, several informal contributions were made by Dr. Frank Granger, Mr. Alejandro Gutierrez, Capt. Rafael Steer, and Prof. Roy Watlington (a full list of participants is available from the secretariat). Then I presented a "strawman" talk on the role of IOCARIBE in a regional tsunami warning network, emphasizing the following main elements: education, modernization, collaboration, and mitigation. Late Thursday afternoon the meeting broke into four sub-groups along the lines of these elements of the IOCARIBE role, and held in-depth discussions to sort out details. These discussions were formally presented to the entire consultation in plenary at mid-morning on Friday, May 24th. During this free-wheeling session, many issues were raised, but most importantly, an action plan was devised that included specific "to do" items, due dates, and the responsible person or agency. Thus when we left VIERS on Saturday morning, not only did we have a draft meeting report, but we had the elements of how to create the warning network.

In summary, the action plan is as follows: 1. Prepare by July an IOC technical report to be made available at the upcoming Second Caribbean Conference on Natural Hazards (Jamaica, October 9-12, 1996). 2. Send four presenters to the above mentioned Conference to speak on: "The History of Caribbean Tsunamis", "Seismisity and Tsunami Generation", "A Proposed Caribbean Tsunami Warning Network", and "Caribbean Tsunami Education". 3. Create a Scientific Steering Committee (SSC) limited to about five key expert persons (initially to include Profs. Maul (chair), Mercado, and Hendry, and Messrs. Lynch and Blackford). 4. Create an inventory of tsunami-warning related infrastructure and also assess the real- time capability of such infrastructure. 5. Commence computer simulations of run-up scenarios and statistics. 6. Distribute existing tsuanmi awareness brochures from ITIC, PTWC, and CEICSE, creating new ones at the IOCARIBE Secretariat only when necessary to emphasize region-specific issues (such as in French, Patois, Dutch, Creole, Papiamento, and other language groups). 7. Report this meeting on the (Internet) Tsunami Bulletin Board, and in the ITSU's Tsunami Newsletter.

Two Great Tsunamis / UJNR Workshop

April 1-3, 1996, Hilo, Hawaii

Sponsors: Tsunami Society and the Natural Sciences Division of the University of Hawaii at Hilo

Convenors: George Curtis and James P Lander

(The following report has been exerpted from the Science of Tsunami Hazards, V. 14, No. 2, a special issue on the Workshop)

A conference was held in Hilo, Hawaii beginning on April 1, 1996 to commemorate the 50th anniversary of the disasterous earthquake and tsunami of the Aleutian Islands and the 100th anniversary of the disasterous earthquake and tsunami of Sanriku, Japan. These events were important in shaping later organization and research on the tsunami problem; the 1946 event initiated research that led to the development of the Pacific Tsunami Warning System. This was the fifth United States - Japan Cooperative Program in Natural Resources (UJNR) symposium/workshop organized by the Task Committee on Storm Surges and Tsunamis of the UJNR Panel on Wind and Seismic Effects. Some 20 scientists from the U.S., 13 from Japan, 2 from Canada, and several non-scientists attended the meeting.

Reverend Tuck Wah Lee, a Hilo survivor of the 1946 tsunami, tells of his experience to an audience at the County Building in Hilo on the 50th anniversary of the event.

The program included:

April 1. A memorial service in the rebuilt area of Hilo that was devastated by thew 1946 and 1960 tsunamis was held in conjunction with local officials and survivors. The afternoon opening ceremonies at the University featured invited speakers who described the effects of the two tsunamis and the role they played in shaping later developments in the field.

April 2. Scientific sessions were held on the latest developments in the field, including instrumentation, warning and mitigation actions, source mechanisms, case studies, and models. An important theme was the application of the lessons learned from past tsunamis to public safety.

April 3. A guided field trip was made to affected sites on Hawaii Island including visits to Hilo harbor, Laupahoehoe, the Civil Defense Office, and the Hawaii Volcano Observatory (site of the earliest tsunami warnings), followed by an informal discussion/closing session and video tapes of numerical models, and a barbeque dinner at the University.

April 4-5. Optional field trips that were held on the island of Oahu included the Pacific Tsunami Warning Center, the International Tsunami Information Center, the new Weather Service Forecast Office, and the Oceanography department at the University of Hawaii at Manoa.

Participants in the "Two Great Tsunamis/UJNR Workshop" held April 1-3, 1996 in Hilo, Hawaii. The workshop commemorated the 50th anniversary of the April 1, 1996 tsunami from Unimak, Alaska that devastated Hawaii, and the 100th anniversary of the June 15, 1896 tsunami from offshore of the Sanriku coast of Japan that killed more than 26,000 residents in nearby coastal villages.

PACON 96

The Seventh Pacific Congres on Marine Science and Technology, PACON 96, was held at the Ilikai Hotel in Honolulu, Hawaii, from June 17-22, 1996. The keynote address "Towards a Pan Pacific Paradigm in the New Millenium" was delivered by Dr. Gunnar Kullenberg, Executive Secretary of the IOC. He stressed the importance of the oceans in earth's future, and discussed the need for increased ocean measurements and observations, modeling, planning-integration, and socio-economics. Dr. Kullenberg also pointed out the need for international cooperation and highlighted some of the current IOC programs that involve international cooperation such as GOOS, GLOSS, GCRMN, and IGOSS.

The meeting included two sessions devoted to tsunamis with papers delivered on tsunami risk assessment, tsunami modeling, secondary tsunami sources, cosmogenic tsunamis, and tsunami deposits. There was also a special workshop on the newly established Pacific Disaster Center being developed jointly by the State of Hawaii Civil Defense and the US Department of Defense to use earth monitoring satellites, ground sensors, and computing resources for creating vital information products regarding a variety of hazards, including tsunamis, for emergency managers in Hawaii and the Pacific region.

UPCOMING MEETING ANNOUNCEMENTS

International Workshop on Tsunami Mitigation and Risk Assessment

August 19-23, 1996, Petropavlovsk-Kamchatskiy, Russia

[The following is from the announcement for the workshop. Results of the workshop will appear in the next issue of the Newsletter.]

Sponsors: IUGG Tsunami Commission; ICG/ITSU IOC/UNESCO; Russian Foundation for Basic Research (RFBR), Moscow; International Tsunami Information Center (ITIC), Honolulu; Kamchatka Regional Administration; Kamchatka Center for Monitoring of Seismic and Volcanic Activity; Computing Center, SD RAS, Novosibirsk; Institute of Computational Technologies, SD RAS, Novosibirsk; Tsunami Research and Information Center (TsuCen), Moscow

Main Objective

The main objective of the Workshop is to evaluate the state-of-the-art research for the long-term estimation of tsunami risk (tsunami-zoning). The final product of the workshop will be recommendations on tsunami-zoning strategies which can be used as a guide for scientists and practitioners to improve the quality and reliability of tsunami risk estimates for coastal areas with different types of seismotectonics and different levels of completeness of historical data. The Workshop will be a forum to present new ideas, suggestions for improvement, and cooperation between different individuals and groups of scientists involved in the estimation of tsunami risk. Participants are invited to discuss plans and experience gained in different case studies, as well as regional and national programs.

Annotated Agenda

Paleotsunami Research: Review of coastal areas where paleotsunami investigations have been made and temporal tsunami-event information of the data will be presented. Special attention will be given to the ways in which geological traces can be translated into tsunami parameters.

Historical Catalogs and Database: Tsunami data - what they are and what they are needed for? How basic tsunami parameters have been estimated? What are the probable errors associated with each significant parameter? Spatial and temporal coverage of the existing tsunami data in catalogs will be presented and methodology for transferring tsunami catalog data into the digital databases in computer-storage form will be discussed. Emphasis will be given for the new communication technologies, e.g. WWW, CD-ROM, FTP management, for providing a remote access to databases.

Seismo-Tectonics of Tsunami: In the earthquake magnitude range from 7.0 to 7.5, less than one-quarter of Pacific submarine earthquakes are tsunamigenic. What are the source characteristics and mechanism of tsunamigenic earthquakes which differ from non-tsunamigenic earthquakes? Distribution of the source pattern of tsunamigenic earthquakes along the Pacific Fire Belt, seismic gaps and their application to the long-term tsunami risk, problems of tsunami-earthquakes will be discussed.

Numerical Models of Tsunami Behavior: The state-of-the-art of the numerical technique for tsunami modeling will be discussed with the special emphasis on the run-up calculation methods and their ability to reproduce the actual distribution of tsunami runup heights measured during recent field surveys.

Methods of Calculation of Tsunami Risk: This will be a key item of the workshop agenda. The review of existing methods of tsunami risk analyses will be given with comparative consideration of deterministic versus probabilistic approaches. Several case studies of tsunami zoning will be presented with the focus on the rational selection of the spatial-temporal scale for tsunami zoning.

Combination of Tsunamis with Other Dangerous Phenomena in Coastal Areas: For a particular coastal region, the tsunami is a very rare phenomenon. Should we take into account its combination with other type of marine disasters (high tides, storm surges)? If so, then how ?

Mitigation and Countermeasures: What should be the final product of tsunami zonation study and what is the policy of practical implementation of tsunami risk studies? Here might be topics on vulnerability of coastal communities to a tsunami impact, preparedness and awareness measures and public response to them, methods of assessment of potential economic loss, hazard insurance, etc.

Tsunami Data Centers: Establishment of tsunami data centers were discussed at the Estes-Park workshop last year. We need to follow up this discussion and hopefully find a concrete means to materialize this idea.

92nd Annual Meeting of the Seismological Society of America

April 9-11, 1997, Hawaiian Regent Hotel, Honolulu, Hawaii

Contact: Patricia Cooper, Asst. Dean, Graduate Division, University of Hawaii at Manoa, 2444 Dole Street, Honolulu, HI 96822, USA,; tel. 808-956-6635; fax 808-956-9797; email pcooper@ginger.bachman.hawaii.edu; URL http://www.seismosoc.org/ssa/htdocs/ssa97.html

Tsunami papers will be presented in the sections entitled "Earthquake Hazard and Risk Assessment", and "Seismicity/Seismotectonis of the Pacific".

22nd General Assembly of the European Geophysical Society

April 21-25, 1997, Vienna, Austria

Contact: EGS Office, Max-Planck-Str. 1, 37191 Katlenburg-Lindau, Germany; tel. +49-5556-1440; fax +49-5556-4709; e-mail egs@linax1.mpae.gwdg.de; URL http://www.mpae.gwdg.de/EGS/EGS.html

The scientific program of the meeting will cover a wide variety of general topics including Solid Earth Geophysics, Oceans and Atmospheres, and Natural Hazards. **Tsunami** presentations will be given in two of the Natural Hazards sessions: Prediction and Management of Extreme Events, and Natural Hazards in Volcanic Areas.

XIVth Oceanology International: Pacific Rim

May 12-14, 1997, World Trade Centre, Singapore

Sponsors: National University of Singapore, Intergovernmental Oceanographic Commission; others

Contact: L.A. Sandbach, Spearhead Exhibitions Ltd., Ocean House, 50 Kingston Road, New Malden, Surrey KT3 #LZ, United Kingdom; tel +44(0) 181-949-9222; fax +44(0) 181-949-8186; email oipacrim@spearhead.co.uk; URL http://www.acrso.ns/ca~spearhead/

Professional in the marine sciences will have the opportunity to attend three international conferences at this venue: OI Pacific Rim '97, which is a broad scientific and technical conference covering measuring, modeling, and prediction of the oceans; COSU '97, which seeks to develop practical partnerships between academia, government, and industry; and IOA '97, which is a forum of the International Ocean Thermal Energy Conversion/Deep Ocean Water Applications Association.

Cordilleran Section, Geological Society of America

May 23-23, 1997, Kona, Hawaii

Contact: Dr. Barbara Keating, Marine Geology, University of Hawaii, 2525 Correa Road, Honolulu, HI 96822, USA; tel. 808-956-8143; fax 808-956-3188; email keating@soest.hawaii.edu; URL http://www.geosociety.org/sectdiv/cord/97meet.htm

To register quickly contact GSA at 303-447-2020

The 93rd annual meeting of the Cordilleran Section of the Geological Society of America will take place in Kona, Hawaii, May 21-23, 1997. There are several sessions on geologic hazards which will be of particular interest to tsunami experts. On Wednesday there is a Symposium on "Landslides and **Tsunamis**, Hawaii and Elsewhere. " In the morning will be the Hawaiian controversy, the first half of which will present evidence that the coral-rich gravels found at high elevations on Lanai are tsunami generated deposits, and the second half presenting evidence that the deposits are not of a tsunami origin. The afternoon will focus on the present, the past, and models. On Thursday will be a session on comparative volcanology, "Submarine and Subaerial; General Volcanology," and on Friday will be a session on "Geologic Hazards: Circum-Pacific and Intra-Pacific; Engineering Geology."

Following the meeting will be a GSA sponsored field trip to the islands of Molokai and Laniai which will examine "Giant wave deposits." Proponents and opponents will both be on hand, which should provide for some lively debates.

Caribbean Tsunami Workshop

June 11-13, 1997 Mayaguez, Puerto Rico

Sponsors: University of Puerto Rico Sea Grant College Program; Puerto Rico State Civil Defense; University of Puerto Rico Research and Development Center; U.S. Army Corps of Engineers; Department of Natural and Environmental Resources of Puerto Rico; Department of Marine Sciences, University of Puerto Rico

Contact: Prof. Aurelio Mercado, UPR-RUM, P.O. Box 5000, Mayaguez, Puerto Rico 00681; tel. (787) 832-4040; fax. (787) 265-5408; e-mail: a_mercado@rumac.upr.clu.edu; URL http://rmocfis.upr.clu.edu/~a_mercad/workshop.html

Professor Aurelio Mercado of the University of Puerto Rico is organizing a tsunami workshop to be held in Mayaguez, Puerto Rico on June 11-13, 1997 with the main objective to follow up on the Intergovernmental Oceanographic Commission (UNESCO) sponsored workshop of last May in the Virgin Islands to consider the need for a Caribbean Tsunami Warning Center. The workshop will consists of a dozen invited papers and panel sessions to develop recommendations. Participation is open. The Caribbean

has a history of over 50 tsunamis and hundreds of fatalities from tectonic, landslide, and volcanic sources including a destructive wave from the 1755 Lisbon teletsunami, but little research or mitigation effort has been done for the region which has a growing risk due to coastal development and tourism. Information on the agenda, participants, and registeration can be found on Web site:

COASTAL 97 -Third International Conference on Coastal Engineering

June 23-25, 1997, La Coruna, Spain

Sponsors: Wessex Institute of Technology and the Universidad de La Coruna, Spain

Contact: S. Owen, COASTAL 97 Conference Secretariat, Wessex Institute of Technology, Ahurst Lodge, Ahurst, Southampton UK SO40 7AA; tel. 44-1703-293-223; fax 44-1703-292-853; email sue@wessex.ac.uk; URL http://www.wessex.ac.uk/conferences.coastal/

COASTAL 97 will bring together coastal, civil, and hydraulic engineers and scientists to discuss computer modeling of seas and coastal regions under extreme and normal conditions, with special emphasis on practical applications currently being carried out around the world. Discussion will also take place on environmental problems of coastal areas which are frequently densely populated or sites of major industrial developments, as well as on the theme of coastal protection and remediation work. Specific conference topics include coastal erosion, oil slicks, wave propagation, shallow water models, **tsunamis**, storm surges, typhoons, pollutant transport and dispersion, and atmospheric effects.

18th International Tsunami Symposium in conjunction with IAMAS-IAPSO Joint Assembly

IAMAS-IAPSO: July 1-9, 1997, Melbourne Convention Centre, Melbourne, Australia

Tsunami Symposium: July 2-4, 1997

Sponsors: CSIRO, International Union of Geodosy and Geophysics, others

IAMAS-IAPSO Contact: IAMAS/IAPSO Secretariat, Convention Network, 224 Rouse St., Port Mebourne, Victoria 3207, Australia,; tel. +61-3-9646-4122; fax +61-3-9646-7737; email mscarlett@peg.apc.org; URL http://www.dar.csiro.au/pub/events/assemblies/

Tsunami Symposium Contact: R.D. Braddock, Environmental Science, Griffith University, Nathan, Qld, Australia; email R.Braddock@ens.gu.edu.au

The IUGG Tsunami Commission will hold its eighteenth international Tsunami Symposium in Melbourne, Australia in conjuction with the Joint Assemblies of the International Association for Meteorology and Atmospheric Sciences (IAMAS) and the International Association for Physical Sciences of the Ocean (IAPSO).

The IAMAS-IAPSO theme is "Earth, Ocean, Atmosphere - Forces of Change", and the various symposia cover topics including large scale variability in atmosphere and ocean systems; chemical processes and climate radiative forcing in climate; cloud processes; air-sea interaction; tropospheric chemistry; and related air-surface exchange in polar regions; volcanoes and climate; and oceanography of the Indian ocean.

The Tsunami Symposium theme is "Tsunamis: Observation and Modeling for Understanding and Mitigation". Papers were solicited on all elements of tsunamis relating to this theme including observations of generation, propagation, and runup; modeling of tsunami hydraulics, historical tsunami studies, risk analysis, mitigation programs, risk management, warning, and education. A tour will be offered to inspect evidence of historical tsunami attacks at sites along the coast of New South Wales. The tour will be hosted by Dr. E. Bryant who has spent considerable time researching historical tsunamis and their evidence.

29th General Assembly of IASPEI

August 18-28, 1997, Thessaloniki, Greece

Contact: B. Papazachos, IASPEI 97 LOC, Geophysical Laboratory, University of Thessaloniki, Greece; tel. +30-31-998501; fax +30-31-998528; email iaspei@olymp.ccf.auth.gr; URL http://ares.csd.net/~bergman/iaspei/g_a_greece_fsp.html#aa560

This meeting of the International Association of Seismology and Physics of the Earth's Interior will provide an opportunity for multidisciplinary scientists to exchange ideas about present day problems of the seismological community. The meeting will include a session entitled **"Tsunami Sources"**, as well as sessions on many other seismological topics either directly or indirectly related to tsunamis.

Natural Disasters, Construction and Safety

September 8-12, 1997, Vladivostok, Russia

For information contact the Organizing Committee at: DalNIIS, 14 Borodinskaya St., GSP, Vladivostok, 690049, RUSSIA; Telephones: 7-4232-460-058, 7-4232-460-077, and 7-4232-460-058, Fax: 7-4232-460-058

The Asia-Pacific Region is a zone of extreme natural and climatic conditions including typhoons, tsunamis, earthquakes, and floods. The damage they cause is estimated at hundreds of billions of dollars and hundreds of thousands of human victims. The objective of this

conference and exhibition is to summarize the world experience in the area of consequences of natural disasters.

The conference is expected to be an event having definite practical purposes. One of the topics to be covered is tsunamis, including the nature and conditions of their origin, and the protection of ports, port facilities, and water recreation areas. Other topics to be covered include typhoons, earthquakes, construction practices, efforts of public organizations, and international cooperation. Along with the conference will be a specialized technical exhibition where domestic and foreign manufacturers will exhibit their technological novelties, products, goods, and services.

Waves 97 - The Third International Symposium on Ocean Wave Measurement and Analysis

November 3-7, 1997, Ramada Plaza Resort, Virginia Beach, Virginia, USA

Sponsors: The Coastal Zone Foundation, American Society of Civil Engineers

Contact: Waves 97 Headquarters, c/o Dr. Billy L. Edge, Ocean Engineering Program, Dept. of Civil Engineering, Texas A&M University, College Station, TX 77843-3136, USA; tel. 409-845-4515; fax 409-862-1542; email b-edge@tamu.edu; URL http://www.tamu.edu/waves97/

Professionals, researchers, and all interested persons are welcomed and encouraged to participate in an international exchange of information and views geared to promote communication, technology transfer, improved design, theoretical hydrodynamics, and practical solutions as well as present case histories relating to wave measurement and analysis. Topis for the meeting include: wave measurement and analysis, **tsunamis**, surges, and seiches, laboratory generation and measurement, wave forecasting and calibration, and coastal flooding.

Modern Prediction and Response Systems for Earthquake, Tsunami, and Volcanic Hazards

April 27-28, 1998, Santiago, Chile

Sponsors: International Association of Seismology and Physics of the Earth's Interior (IASPEI), International Association of Volcanology and Chemistry of the Earth's Interior (IAVCEI)

Contact: Bruce A. Bolt, Department of Geology and Geophysics, University of California, Berkeley, CA, USA; fax 510-845-4816; email boltuc@socrates.berkeley.edu; or J. Gutierrez, Instituto Geográfica Militar, Santiago, Chile; fax 56-2-698-8278, email igm@reuna.cl

This meeting is a contribution of the IASPEI Commission for the IDNDR. Additional information about the meeting will posted in the newsletter as it becomes available.

PACON 98: Eighth Pacific Congress on Marine Science and Technology

June 16-20, 1998, Seoul, Korea

Sponsors: Korea Ocean Research and Development Institute; American Geophysical Union

Contact: N. Saxena, PO Box 11568, Honolulu, HI 96828, USA; tel 808-956-6163; fax 808-956-2580; email: saxena@wiliki.eng.hawaii.edu

Abstract Deadline: January 15, 1998

The theme of PACON 98 is "Towards the 21st Century - A Pacific Era". It will bring together scholars and resource managers to address key issues concerning marine technology as related to the ocean economic potential of the region. Discussion topics include public policy, technology, economic and environmental research, and observations of the Pacific region. Specific technical sessions include: land reclamation/coastal zone development; climate change and development of the waterfront; marine application of GPS; **tsunamis**; marine environmental protection; ocean energy; and new developments in marine geologic mapping.

PUBLICATIONS

Science of Tsunami Hazards

published by The Tsunami Society

Volume 14, Number 1

Observations of tsunami "shadows": technique for assessing tsunami wave heights?, Daniel A. Walker

Numerical model for tsunami generation due to subaqueous landslaide along a coast: a case of the 1996 Flores Tsunami - Indonesia, Fumihiko Imamura and Edison C. Gica

Spectral Decomposition in the wave propagator approach to finite element tsunami modeling, Stefano Tinti, Elisabetta Bortolucci, and Alessio Piatanesi

On some properties of the FE tsunami "wave propagator", Stefano Tinti, Alessio Piatenesi, and Elisabetta Bortolucci

Earthquakes, tsunamis, and tectonic setting of the Japan Trench and the southwestern Kuril Trench areas, Ei-ichi Honza and Augustine S. Furumoto

Volume 14, Number 2

(This issue is devoted to papers presented at the Two Great Tsunamis / UJNR Workshop held in Hilo, Hawaii April 1-2, 1996)

Two Great Tsunamis / UJNR Workshop, George Curtis and James P. Lander

Source model of the 1946 Aleutian tsunami derived from the predominant frequencies, Kuniaki Abe

Human factors compounding the destructiveness of future tsunamis, Daniel A. Walker

Asteroid tsunami inundation of Hawaii, Charles L. Mader

Can a submarine landslide be considered as a tsunami source, Sin-Iti Iwasaki, Augustine Furumoto, and Eiichi Honza

Tsunami risk reduction: The Oregon strategy, George R. Priest, D.A. Hull, B.F. Vogt, A. Karel, and D.A. Olmstead

Using Mw or Mt to forecast tsunami heights, Augustine S. Furumoto

Numerical simulation of the propagation of the 1993 southwest Hokkaido earthquake tsunami around Okushiri Island, Shinji Sato

Damages of coastal structures in Awaji and Touban coasts due to 1995 Hyogoken Nambu earthquake, Shigenobu Tanaka and Shinji Sato

INTERNET / WORLD WIDE WEB

Tsunami Laboratory of the Novosibirsk Computing Center

In mid-1996, the Tsunami Laboratory of the Novosibirsk Computing Center (NCC) established its own home page:

http://www.sscc.ru/aleks/tsulab

which is currently part of the institute's web site:

http://www.sscc.ru

It contains information about ongoing research projects of the laboratory (Expert Tsunami Database, Estimation of Tsunami Risk on the Far-East Coast of Russia, Investigation of Paleotsunami Traces in Kamchatka, Kamchatka Tsunami Workshop), a list of the laboratory's staff, and selected publications. In the section on "recent tsunamis"

http://www.sscc.ru/aleks/tsulab/recent.html

there is information about recent Pacific tsunamigenic events which includes seismic source data, local maps of historical seismic and tsunami activity, measured run-up heights, textual description of tsunami manifestations, and a list of references. Currently, the full set of information is available for the last four tsunamigenic events

04 October 1994	Ms=8.1	Shikotan, Russia
01 January 1996	Ms=7.7	Sulawesi, Indonesia
17 February 1996	Ms=8.1	Irian Java, Indonesia
21 February 1997	Ms=6.7	Northern Peru

In near future this list will be extended to cover all the Pacific tsunamis of 1992-96. Very soon this section will also include an interactive background map of the Pacific which can be used for the location of tsunamigenic events and for retrieval of information about them, simply by clicking on an active box associated with a source area.

WC/ATWC Establishes Web Site

The West Coast / Alaska Tsunami Warning Center, the regional tsunami warning center for Alaska and the west coasts of the US and Canada, has recently established a web site at:

http://www.alaska.net/~atwc/

The table of contents for the site includes:

- West Coast / Alaska Tsunami Warning Center Mission
- Earthquake Catalogs
- Tsunami Catalogs
- Most Recent Public Information Message
- Physics of Tsunamis
- Tsunami Safety Rules

In the section under "Most Recent Tsunamis" is a page for the June 10, 1996 tsunami that includes links to 38 tide records for the event including the record used on page 12 of this newsletter.

WARNING CENTER ACTIVITIES

ATWC becomes West Coast / Alaska Tsunami Warning Center (WC/ATWC)

Effective January 1, 1997 the former Alaska Tsunami Warning Center in Palmer, Alaska changed its name to the West Coast / Alaska Tsunami Warning Center (WC/ATWC). This change was made at the request of the U.S. Tsunami Warning Program to reflect the new area of warning responsibility for the center that now includes the U.S. west coast. All other information about the center such as phone numbers, personnel, and email addresses remain unchanged.

Adak Tide Station Detects Tsunami

(information provided by Mickey K. Moss of the US National Ocean Service)

The latest version of Sutron (2.5F) and US National Ocean Survey (Rev HT+) software was installed in the Adak, Alaska Tide Station just one week prior to the June 10, 1996 tsunami. The software includes an algorithm to quickly detect the presence of a tsunami signal in the normal tide record and then initiate emergency transmissions of the data through the GOES satellite for use by the warning centers. Emergency transmissions take place every five minutes, and provide water level data sampled at one-minute intervals. This compares with normal transmissions which occur only once every three hours and provide data sampled at six-minute intervals. The new software performed flawlessly on June 10, detecting the tsunami and providing a 3hr 50min seamless record of the tsunami signal at Adak through 46 emergency transmissions. The software also provides the possibility for retrieving the most recent 22 days of data, sampled at one-minute intervals, through a telephone-modem connection. In addition, data sampled at 15-second intervals is stored on a 720-Kbyte RAM cartridge that can be physically removed following a tsunami to provide research-quality data. Both of these features were exercised following the event and performed as intended.

New Geophysicist Joins PTWC

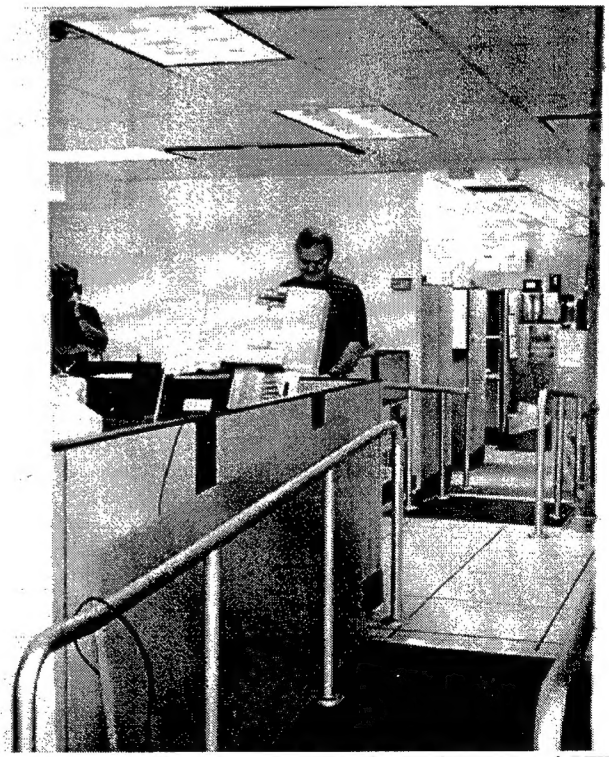
Mr. Barry Hirshorn, formerly with the US Geological Survey at Menlo Park, California, joined the staff of PTWC as a watchstander geophysicist in late February, 1996. He filled a position that had become available several months earlier when Chip McCreery left to join ITIC. Barry worked on automatic rapid detection and evaluation of earthquakes at Menlo Park, and is now helping to transfer some of the related USGS software to PTWC.

The staff of the PTWC is currently:

Mr. Michael Blackford	Geophysicist-in Charge
Mr. Bruce Turner	Geophysicist
Dr. William Mass	Geophysicist
Dr. Robert Cessaro	Geophysicist
Mr. Barry Hirshorn	Geophysicist
Ms. Jill Wessel	Geophysicist
Mr. Richard Nygard	Senior Electronics Technician
Mr. Steve Wallace	Electronics Technician
Ms. Lynn Kaisan	Electronics Technician
Ms. Marilyn Ramos	Secretary

PTWC Modernization Update

Renovation and modernization of the PTWC facilities continued through the first half of 1996, including almost a complete gutting and redesign of the operations/offices building, installation of a raised floor, and purchasing of new furniture. The center was kept operational throughout this process by moving most of the operations equipment into a small protected corner of the building, and moving the offices into a temporary trailer. A complete photo report on the renovations will appear in the next newsletter.



A view from the reception area into the newly renovated PTWC operations area (elevated by raised flooring), and further back into the staff offices. Richard Nygard, Senior Electronics Technician, is on the phone on the left, and Bruce Turner, Geophysicist, is in the center at the photocopy machine.

Summary of Pacific Basin Earthquakes: January - June, 1996

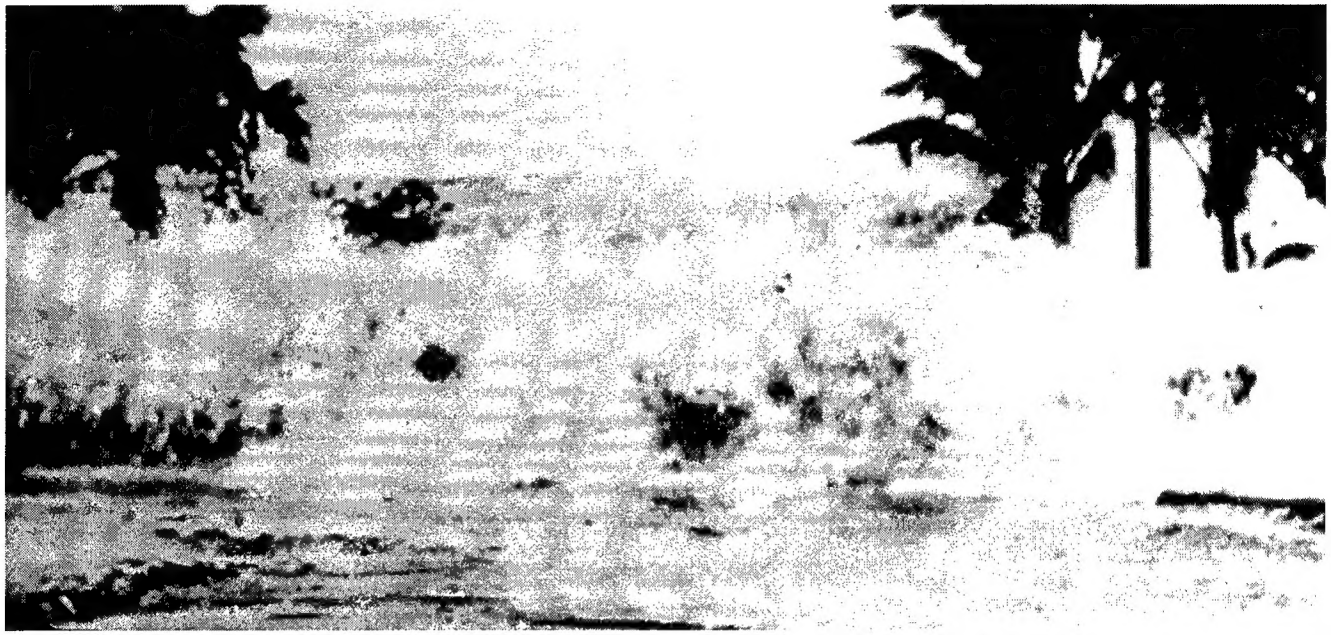
with Surface Wave or Moment Magnitudes Greater than or Equal to 6.5

(data provided by PTWC, ATWC, JMA, and NEIC)

Event	Date	Location	Time UTC	Lat.	Lon.	Dep. (km)	Ms	Mw	Action	Issued UTC
96-01	Jan 1	Sulawesi Indonesia	0805Z	0.5N	119.9E	33	7.7	---	PTWC/TIB	0903Z
96-02	Jan 1	Kamchatka Russia	0958Z	55.1N	160.9E	33	6.5	---		
96-03	Jan 30	Kermadec Islands	2230Z	32.6S	178.3W	4	6.8	6.4	PTWC/TIB	0003Z
96-04	Feb 7	Southern Kuril Islands	2137Z	45.2N	150.0E	36	7.0	7.1	PTWC/TIB	2212Z
96-05	Feb 16	Off E. Coast of Honshu	1523Z	37.1N	142.6E	14	6.1	6.6		
96-06	Feb 17	Irian Jaya Region Indonesia	0600Z	0.1S	137.0E	21	8.0	7.9	PTWC/RWW	0658Z
96-07	Feb 21	Off W. Coast of Peru	1251Z	8.2S	82.0W	5	6.9	7.3	PTWC/TIB	1353Z
96-08	Feb 25	Oaxaca Mexico	0308Z	15.7N	97.8W	33	7.0	7.0	PTWC/TIB	0349Z
96-09	Mar 3	Nicaragua	1455Z	12.1N	86.0W	10	6.4	6.8		
96-10	Mar 3	Nicaragua	1637Z	11.4N	86.3W	14	6.7	6.8	PTWC/TIB	1724Z
96-11	Mar 16	Bonin Islands	2204Z	29.0N	138.9E	471	6.4*	6.6		
96-12	Mar 17	Vanuatu Islands	1449Z	13.8S	167.6E	159	5.9*	6.6		
96-13	Mar 22	Rat Islands Aleutian Islands	0324Z	51.3N	178.9E	7	6.7	6.8	PTWC/TIB	0349Z
96-14	Apr 16	Tonga Islands	0031Z	22.9S	176.9W	93	7.1*	7.1	PTWC/TIB	0127Z
96-15	Apr 19	Northern Chile	0020Z	23.0S	69.8W	46	7.2	6.6	PTWC/TIB	0120Z
96-16	Apr 29	Solomon Islands	1441Z	6.4S	154.9E	44	7.4	7.1	PTWC/TIB	1523Z
96-17	May 2	Solomon Islands	0232Z	6.3S	154.3E	33	5.3	6.5		
96-18	May 2	Solomon Islands	1333Z	4.6S	154.8E	511	6.0*	6.5		
96-19	Jun 9	Northern Mariana Islands	0112Z	17.4N	146.0E	150	6.1*	6.5		
96-20	Jun 10	Vanuatu Islands	0104Z	13.5S	167.1E	185	5.5*	6.7		
96-21	Jun 10	Andreanof Islands Aleutians	0403Z	51.4N	177.8W	9	7.7	7.9	PTWC/RWW	0440Z
96-22	Jun 10	Andreanof Islands Aleutians	1526Z	52.4N	176.9W	16	7.2	7.1	PTWC/RWW	1624Z
96-23	Jun 11	Samar Island Philippines	1823Z	13.2N	125.0E	39	6.9	6.9	PTWC/TIB	1925Z
96-24	Jun 17	Flores Sea Indonesia	1121Z	6.6S	120.3E	585	6.7*	7.8	PTWC/TIB	1232Z
96-25	Jun 21	Kamchatka Russia	1357Z	52.0N	159.0E	4	6.6	7.0	PTWC/TIB	1449Z

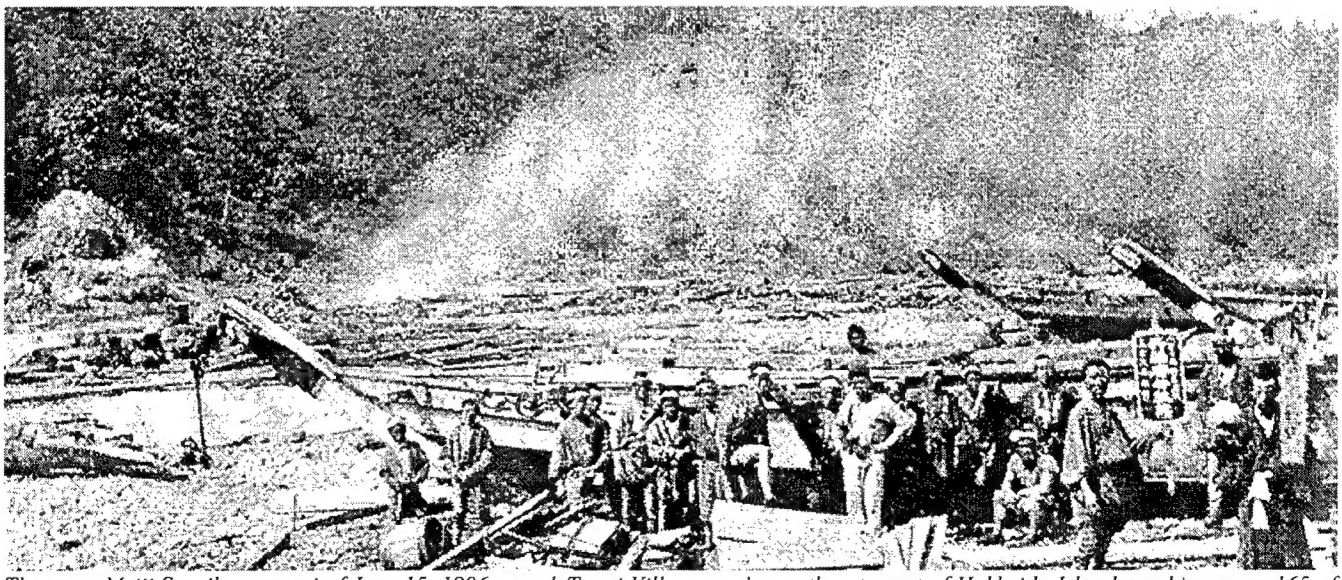
* *indicates mb for the case of deeper focus earthquakes*

50th Anniversary of the Tsunami of April 1, 1946



Tsunami generated by the earthquake of April 1, 1946, striking the beachfront area of Puumaile Tuberculosis Hospital on the island of Hawaii, about 3,800 km from the generating area near Unimak Island, Aleutian Islands, Alaska. In this part of the island, east of Hilo, waves were 6.1-m high, overtopping the breakwater and fortunately causing only minor flooding at the hospital. The rest of Hawaii wasn't so lucky as the waves struck suddenly and unexpectedly with runups as high as 17m, causing 159 fatalities and US$26 million in property damage (in 1946 dollars). [Photo Credit: Mrs. Harry A. Simms, Sr.]

100th Anniversary of the Tsunami of June 15, 1896



The great Meiji Sanriku tsunami of June 15, 1896, struck Touni Village on the northeast coast of Hokkaido Island, washing away 165 of 166 houses and killing 769 persons - nearly 90% of the population of the village. The 104 people who survived were either out at sea fishing or were away for the Boy's Festival. The photo shows some of the fishermen, their boats behind them, after they returned to shore and found their homes and families gone. In total, the tsunami caused over 26,000 fatalies and washed away more than 11,000 houses along this Japanese coast. [Photo and account from the book entitled "Meiji Sanriku Ootsunami."]

MEMBER STATES OF THE

INTERNATIONAL COORDINATION GROUP FOR THE TSUNAMI WARNING SYSTEM IN THE PACIFIC